ROYAL SOCIETY
OF
TASMANIA

PAPERS & PROCEEDINGS

OF THE

ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1923

(With 13 Plates and 19 Text Figures)

ISSUED 9th APRIL, 1924

PUBLISHED BY THE SOCIETY

The Tasmanian Museum, Argyle Street, Hobart
1924

Price. Ten Shillings

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ROYAL SOCIETY OF TASMANIA

The Royal Society of Tasmania was founded on the 14th October, 1843, by His Excellency Sir John Eardley Eardley Wilmot, Lieutenant Governor of Van Diemen's Land, as "The Botanical and Horticultural Society of Van Diemen's Land." The Botanical Gardens in the Queen's Domain, near Hobart, were shortly afterwards placed under its management, and a grant of £400 a year towards their maintenance was made by the Government. In 1844, His Excellency announced to the Society that Her Majesty the Queen had signified her consent to become its patron; and that its designation should thenceforward be "The Royal Society of Van Diemen's Land for Horticulture, Botany, and the Advancement of Science."

In 1848 the Society established the Tasmanian Museum; and in 1849 it commenced the publication of its "Papers and Proceedings."

In 1854 the Legislative Council of Tasmania by "The Royal Society Act" made provision for vesting the property of the Society in trustees, and for other matters connected with the management of its affairs.

In 1855 the name of the Colony was changed to Tasmania, and the Society then became "The Royal Society of Tasmania for Horticulture, Botany, and the Advancement of Science."

In 1860 a piece of ground at the corner of Argyle and Macquarie streets, Hobart, was given by the Crown to the Society as a site for a Museum, and a grant of £3,000 was made for the erection of a building. The Society contributed £1,800 towards the cost, and the new Museum was finished in 1862.

In 1885 the Society gave back to the Crown the Botanical Gardens and the Museum, which, with the collections of the Museum, were vested in a body of trustees, of whom six are chosen from the Society. In consideration of the services it had rendered in the promotion of science, and in the formation and management of the Museum and Gardens, the right was reserved to the Society to have exclusive possession of sufficient and convenient rooms in the Museum, for the safe custody of its Library, and for its meetings, and for all other purposes connected with it.

In 1911 the Parliament of Tasmania, by "The Royal Society Act, 1911," created the Society a body corporate by the name of "The Royal Society of Tasmania," with perpetual succession.

The object of the Society is declared by its Rules to be "the advancement of knowledge."

His Majesty the King is Patron of the Society; and His Excellency the Governor of Tasmania is President.

ROYAL SOCIETY OF TASMANIA

PAPERS AND PROCEEDINGS, 1923

CONTENTS

PAPERS

OF THE

ROYAL SOCIETY OF TASMANIA

1923

STUDIES IN TASMANIAN MAMMALS, LIVING AND EXTINCT.

Number VIII.

By

H. H. SCOTT, Curator of the Launceston Museum,

and

CLIVE E. LORD, F.L.S., Director of the Tasmanian Museum.

(Read 26th February, 1923.)

PLEISTOCENE MARSUPIALS FROM KING ISLAND.

The present specimens relate to the same find as that noted in our communication to this Society upon 13th June, 1921, when we detailed the characters relating to the humerus of *Zaglossus harrissoni.*

Nototherium mitchelli, Owen.—Female (?) animal. Our claim (1920, p. 24 and p. 107) that the plaster cast studied by Professor Owen, and practically elevated by him to the status of a type, was made from the skull of a female animal, is once more our theme, and the evidence is of some considerable interest. Of the animal to be studied, we have the nasal platform, some parts of the zygomatic arch, one tusk, the right upper maxillary with parts of four teeth *in situ,* and the fifth present, but detached. In addition to this, the atlas, axis, and third cervical are available to us—a most fortunate group of associated bones in view of the nature of our inquiry. We have given (1920, p. 81) a table of the calipered thicknesses of Nototherian nasal platforms, and to this we now add the following data:—

N. MITCHELLI.

	Female.	Male.
Thickness of right nasal boss	47 mm.	60 mm.
Thickness of left nasal boss	49 mm.	59 mm.
Central thickness of nasal platform	17 mm.	25 mm.
Thickness at base of nasal cartilage studs	18 mm.	22 mm
Thickness midway between studs and nasal bosses	16 mm.	16 mm
Width of nasal platform	160 mm.	175 mm.

As far as it is possible to compare actual bones with a cast, these data agree very well with the skull case in question. In the item of total platform width, they agree exactly, since both give 160 mm. as a result.

Again, the general all-round reduction in size agrees with what might be expected from a female animal's skull, when studied in terms of a male animal of the same species. The surface of the bone of this nasal platform is so well preserved that it is easy to note even minute, superficial markings, and we accordingly supplied a sketch illustrating the contours, and grouping of vascular scars, etc., the diagram, we opine, being self-explanatory. Upon the assumption that the female animals carried a less massive nasal horn than the males, it naturally follows that the cervical vertebræ would share in a dimensional reduction, and this is exactly what we find to obtain.

COMPARATIVE CERVICAL VERTEBRÆ.

Assumed female.	Atlas.	Assumed Male.
Height of atlas	95 mm.	100 mm.
Anterior height of neural canal ..	60 mm.	77 mm.
Anterior width of neural canal ..	50 mm.	56 mm.
Across atlantean cups	110 mm.	125 mm.
	Axis.	
	mm. mm.	mm. mm.
Diameter of anterior centrum ..	82 x 40	100 x 50
Anterior width of neural canal ..	40	46
	Cervical 3.	
	mm. mm.	mm. mm.
Diameter of anterior centrum ..	62 x 42	75 x 47
Anterior height and width of neural canal	22 x 40	31 x 47

TUSK.

The single tusk belongs to the right upper side of the mouth, and what was said (1920, p. 107) needs little, if any, emendation, namely, "Female tusks flatter in outline, less "divergent, and less powerful in outline." As nothing remains to us anteror of the premolar, except the said tusk, and perhaps a mandibular tusk—to be noted later on—any remarks supplied respecting the amount of divergence would be largely speculative, deduced from a comparison with other King Island and Mowbray Swamp specimens, and if this is done the best conclusion we can arrive at is that, for the present at any rate, the descriptive terms "less divergent"

hold good. As to size, the specimen measures in total length, between verticals, 134 mm., and seems to be intact. As usually obtains, the lower surface of the exposed area of the tusk is deeply excavated by the lower tusk, a sharply drawn cross line marking its point of contact with the second incisor (whose whole crown is generally excavated to the outline of the grinding surface of the mandibular tusk).

GENERAL CONCLUSIONS.

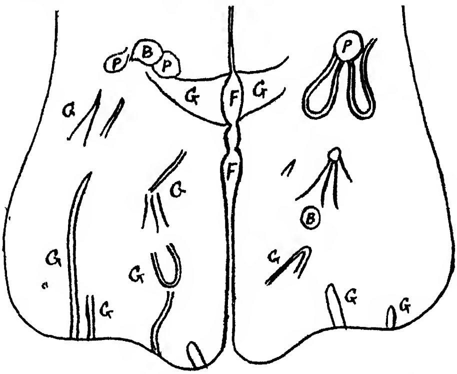
It would seem, therefore, that—as already suggested—the females of *Nototherium mitchelli* were fully armed and carried effective nasal horns, albeit less powerful than those of their mates. This conclusion is supported by the facts deduced from the study of the less solidly built nasal platforms, and weaker necks. That we are not here dealing with an immature male seems fairly assured, since the bones all suggest maturity, and the teeth have been well worn during the life of the animal. No feasible method of osteological development seems capable of converting this, apparently, matured nasal platform. of 160 mm. in width, into one of 175 mm. or more, or of expanding the cervical vertebræ to the size commensurate to the aggressive nature of the male animal. As noted in our former communication the specimens were recovered, and sent to us by Mr. K. M. Harrisson, of Smithton, during a trip to King Island upon survey work.

LITERATURE REFERRED TO.

1920 H. H. Scott and Clive Lord, Papers and Proceedings of the Royal Society of Tasmania, 1920, pp. 24 81, and 107.

NASAL PLATFORM OF *N. MITCHELLI*, ♀

Showing vascular grooves and scars relating to nourishment and repair of the horn.



NOTE.—Not drawn to scale.
B—Boss. F—Foramen. G—Groove. P—Pit.

STUDIES IN TASMANIAN MAMMALS, LIVING AND EXTINCT.

Number IX.

By

H. H. Scott, Curator of the Launceston Museum,

and

Clive E. Lord, F.L.S., Director of the Tasmanian Museum.

(Read 26th February, 1923.)

NOTOTHERIUM VICTORIÆ, OWEN.

Among the specimens recovered by Mr. K. M. Harrisson from the swamp lands of King Island, we have to record specimens relating to *Nototherium victoriæ*, which include the following items.

1. The right and left rami of the mandible of a young animal, minus the premolars in either case, but having upon the right side, in addition to molars 4, 3, and 2, the tusk relating to that half of the jaw. Upon the left side, there are present molars 4, 3, 2, 1. All the teeth manifest the character of immaturity, incidentally demonstrated by the small amount of wear, and the actual bone tissue is much lighter in texture than that seen in matured specimens from the same locality. The absence of premolar teeth is most unfortunate. and curiously enough all the Nototherian jaws yet received from King Island are in a similar condition Our present note is rather to record than describe the find, since they are chiefly valuable in a comparative connection.

2. The associated right and left upper maxillaries, from a skull of an older animal than that which supplied the mandible, the bony tissue being fully ossified and the teeth worn down to smooth surfaces. The right moiety gives us molars 4, 3, 2, 1, all *in situ*, and much in the same condition as they were when the animal was alive. Upon the left side molar 4 is present, but is detached, and molar 3 is mutilated at the point of contact with molar 4. Molars 2 and 1 are intact and still *in situ*.

NOTOTHERIAN TUSKS.

The tusk recorded above agrees exactly with specimens previously received from King Island, through the kindness of Mr. F. H. Stephenson, and its place in the skull can be stated with certainty since the complete set of four tusks were found with the bones recovered by Mr. Stephenson.

We are thus quite sure as to the kind of tusk that should be associated with skulls of *Nototherium victoriæ,* also the tusks of the male of *Nototherium mitchelli* are available for study, and, as already stated in our note upon the supposed female animal of that species, we have an upper tusk that in a general way conforms to the characters of the male of that species, but is upon the whole rather flatter. Mr. Harrisson's material also supplies us with a tusk that might very well represent the lower tooth of the female of *N. mitchelli,* whose remains we have just passed in review, since its ground point exactly fits the tusk relegated to that animal—also the second worn surface agrees very closely with the kind of wear associated with the second incisor of the upper jaw. If this relegation is a correct one, and we provisionally so place it, then the lower tusks of females of *N. mitchelli* depart somewhat from those of the males, and hold a middle place between the male tusks and those of *Nototherium victoriæ.* This is not a point to be pushed to an extreme limit, but is a side note that awaits future confirmation or otherwise. We have spent a lot of time over the classification of this tusk, and have been always driven back to the conclusion named, and therefore leave the matter at this stage with the hope of obtaining in the future further material for study.

STUDIES IN TASMANIAN MAMMALS, LIVING AND EXTINCT.

Number X.

By

H. H. Scott, Curator of the Launceston Museum,

and

Clive E. Lord, F.L.S., Director of the Tasmanian Museum.

(Read 26th February, 1923.)

GIANT WALLABY.

Macropus anak, Owen.

(Protemnodon anak.)

As is generally known, the animals called by Owen *Protemnodon anak*, *Protemnodon og*, and in part also *Sthenurus atlas*, now figure upon the lists as *Macropus anak* and *Sthenurus atlas*. In the British Museum Catalogue of Fossil Marsupials the late Richard Lydekker says at page 216:—"The followng specimens include those referred by Owen to "*Protemnodon anak*," and of the ten folios that follow, attention is drawn to No. 38,753—a left ramus from Queensland which Owen figured in Phil. Trans., 1874, plate 25, figs. 7 to 10. From the (recently acquired) material Mr. K. M. Harrisson obtained at King Island, we select for description a similar left ramus, that has no other skull associates, but supplies us with various parts of the skeleton. The premolar is missing, and the last molar has been badly mutilated, but the fangs of both broken teeth supply useful data. In total length, from the tips of the tusk to the end of the molar series, the measurement is 127 mm. both in our specimen and in Professor Owen's figure. The total length of the cheek series is given by Lydekker as being 66 mm., and this appears to agree exactly with our specmen if due allowance is made for the missing teeth—restoration being based on the alveolar evidence, and the comparative data supplied by Owen's figure. If our ramus is placed over the wood cut, it covers it, except for a slight reduction in stoutness which is obviously individual, and all its characters and measurements agree in other directions. Seemingly therefore the fossil Wallaby listed at the British Museum under No. 38,753 is here represented by a similar left ramus of the mandible, and the following parts of the skeleton now to be passed in review.

HUMERI.

	Right Humerus.	Left Humerus.
Total length (rubbed)	224 mm.	228 mm.
Greatest proximal width	56 mm.	57 mm.
Least proximal width	50 mm.	51 mm.
Girth of shaft including the pectoral ridge	103 mm.	101 mm
Head to deltoid tubercle	90 mm.	95 mm.
End of supinator ridge to the entepicondylar foramen	60 mm.	63 mm.
Articular width of distal condyles	46 mm.	46 mm.

That these two humeri are the associated arm bones of the same skeleton as that which supplied the ramus of the mandible, there seems to be no reasonable doubt, and the same applies to the appended descriptive data collected from the other bones available to us.

FEMORA.

Unfortunately, neither femur is intact, the left being only represented by the shaft, while the right supplies a shaft, and a complete distal end, but fails us at the floor of the trochanterian fossa. In these circumstances we are without knowledge as to the actual head, but the information supplied by these two bones leaves us in no doubt as to the kind of femur that obtained in this fossil skeleton. Seen in profile, the shaft is straighter than in modern animals, and the rotular groove does not ascend the shaft as in our living Wallabies, but spreads itself out into a more decided rotular fossa, the upper wall of which slowly subsides upon the surface of the shaft. Muscular scars and foramina are similar, and the condyles agree fairly well upon all their articular faces, but the intercondylar fossa is formed at an equal cost to either condyle, and not at a marked toll upon the internal condyle as in the Wallaby of to-day.

TABLE OF MEASUREMENTS.

Total length of imperfect specimen	251 mm.
Distal condyles to floor of trochanterian fossa ..	225 mm.
Greatest distal width	67 mm.
Least distal width	56 mm.
Girth in centre of shaft	93 mm.
Girth above condyles	139 mm.
Girth around condyles	220 mm.
Greatest proximal width in the mutilated specimen which includes about 25 mm. of the trochanter above the floor of the fossa	66 mm.

All the above relate to the right femur, the left being reduced to a diaphysis of 145 mm. in length. This latter enables us to note that the bony substance of the shaft varies from 4 to 7 mm. according to the presence or absence of external muscular attachment scars.

Some twenty vertebræ, a calcaneum, and part of the sternum are among the available items, also parts of both ulnæ, the head of a radius, and the glenoid end of a scapula. The calcaneum is much stouter than that of the modern Forester Kangaroo, although similar as to length, the facets it presents suggest interesting points of comparison with that of the modern wallaby, with which it of course more closely agrees (upon the whole) than with the same bone from the foot of the kangaroo.

As a recent note from the pen of L. Glauert, F.G.S., of the Perth Museum (*vide* Pleistocene Fossils from the Fitzroy River, Kimberley, Western Australia, in Royal Society's Journal, Vol. 7), records a similar find, we have detailed our specimens for comparison.

CONCLUSION.

In reviewing Mr. K. M. Harrisson's King Island find, we see that the material has yielded specimens of the following animals:—

1. *Zaglossus harrissoni*,
2. *Nototherium mitchelli*,
3. *Nototherium victoriæ*,
4. *Macropus anak* (Owen's "*Protemnodon anak*"),
5. Bones of modern wombats, wallabies, and kangaroos,

the whole being associated in a common matrix.

The matrix in question is very like that of Smithton, being in point of fact exactly similar drained bog land, and the bones are in need of exactly the same form of treatment for future preservation. We beg to record our thanks to Mr. Harrisson for his kindness in presenting these very interesting remains to our Tasmanian Museums, thus enabling us to slowly build up valuable comparative collections of the extinct Pleistocene Marsupials.

NOTES ON A GEOLOGICAL RECONNAISSANCE OF MT. ANNE AND THE WELD RIVER VALLEY, SOUTH-WESTERN TASMANIA.

By A. N. Lewis, *M.C., LL.B.*

SYNOPSIS.

1. Introductory.
   - (a) General.
   - (b) Geographical position and access.
   - (c) Routes followed.
   - (d) Previous literature and acknowledgments.
2. Physiographical Geology.
   - (a) Present topography.
   - (b) Development of present topography.
3. Stratigraphical Geology.
   - (a) Pre-Cambrian.
   - (b) Early Palæozoic.
   - (c) Permo-Carboniferous and Trias-Jura.
   - (d) Diabase intrusions.
   - (e) Post-diabase sediments.
4. Glacial Geology.
   - (a) Descriptive account of glacial action on Mt. Anne.
   - (b) Glacial epochs in Tasmania.
   - (c) Cycle of glacial erosion in Tasmania.
   - (d) Other signs of glaciation in the area.
5. Economic Possibilities.
   - (a) Mining.
   - (b) Agricultural.
6. Appendices.
   - (a) Extract from an account by H. Judd.
   - (b) Explanation of Plates.
   - (c) List of Works referred to in text.

1. INTRODUCTORY.

(a) General.

Major L. F. Giblin, D.S.O., and Mr. A. V. Giblin during the Christmas holidays of 1920, 1921, and 1922, organised and led three successive trips into the little-known country that surrounds Mt. Anne. The parties met with considerable difficulties, and most of the available time was used up in the endeavour to reach Mt. Anne, so the opportunities

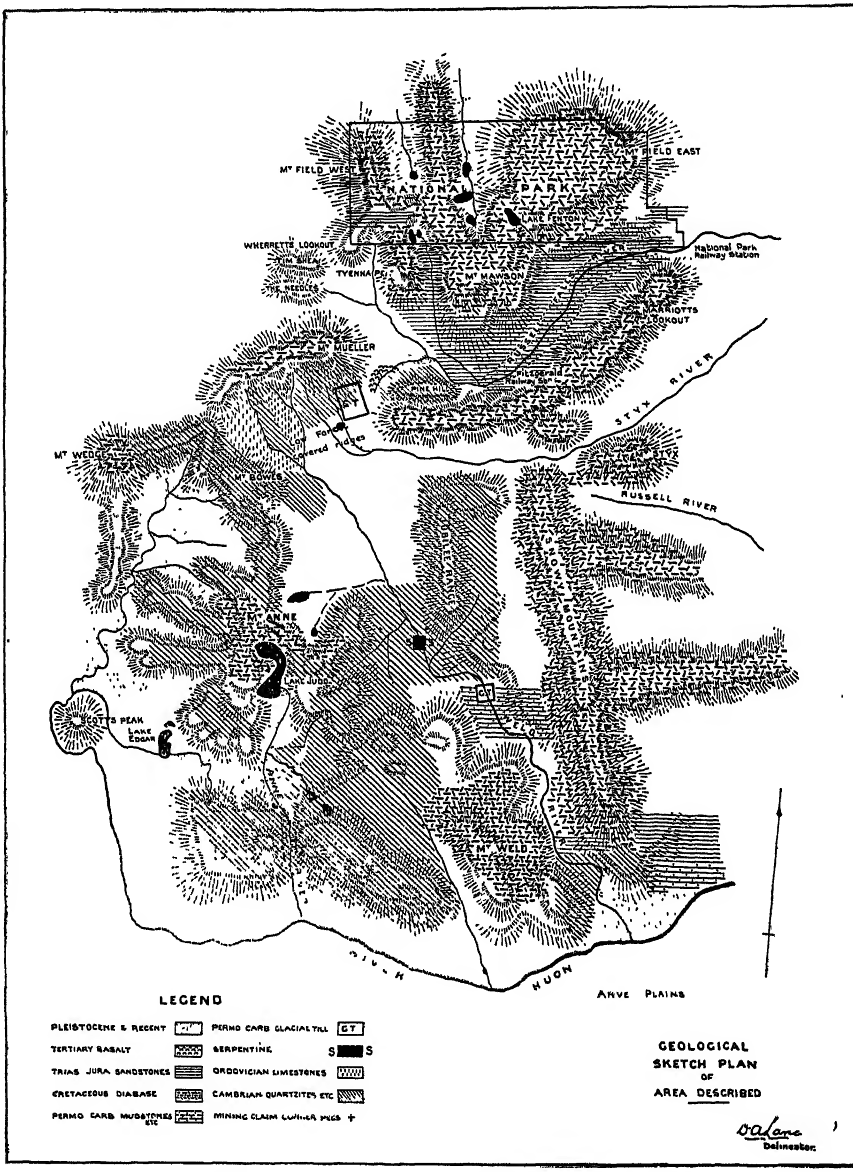
for an investigation of geology were few, but these fragmentary notes may be of assistance to future investigators.

(b) Geological Position and Access.

Mt. Anne lies about 45 miles due west from Hobart, near the head of the Huon River. From the top of the Tyenna Valley a line of rough hills runs westward from Mr. Mueller through Mt. Wedge to the Valley of the Serpentine. Farther west the rugged and almost unexplored Frankland and Arthur ranges bar the way to the West Coast and Port Davey. South of Tyenna, running towards the Huon Valley, is a confused mass of hills of varying height which to the east join up with Mt Wellington. Between these two ranges is a large basin, twenty miles across in every direction, in the centre of which rises Mt. Anne, the most outstanding peak in South-West Tasmania. It is the highest point of a short ridge which extends on every side in a number of spurs. To the west is the broad, flat, swampy valley of the Huon, which passes without a perceptible divide across to the Serpentine, flowing from Lake Pedder to the Gordon. To the east runs the River Weld in a series of gorges and steep-sided valleys all filled with almost impenetrable jungle.

The area reviewed in this paper extends from the vicinity of Fitzgerald on the Russell Falls River, on the north, to the junction of the Huon and Weld rivers, on the south. These points are approximately the end of cultivation in this part of Tasmania. The area is bounded on the west by the Huon River.

Mt. Anne lies over thirty miles beyond the point to which roads have yet been pushed, and there is no natural feature giving ready access. The easiest route to the mountain is along the Tyenna-Port Davey track, which, starting where the southern road from Fitzgerald ends at Mayne's selection, winds round Mt. Mueller and Mt. Bowes to the Huon Plains, and eventually crosses the Huon River 25 miles from the end of the road. The track is a good one till it crosses Mt. Bowes and is at present passable for pack horses. On the Huon Plains, however, it is in a general state of disrepair, with bridges down and overgrown with bauera scrub and other obstacles. From the point at which the track crosses the Huon, Mt. Anne can be reached across open buttongrass plains. The second of the two western spurs presents a possible route to the summit of the Mt. Anne plateau.



ERRATA:—In Legend, for Ordovician Limestones read Silurian Limestones, and for Cambrian read Cambro-Ordovician.

SKETCH MAP OF MT. ANNE AREA.

Approximate Scale—Eight miles to the inch. Details approximate.

In the south of the area a passable road extends up the north bank of the Huon as far as the divide between the Denison and the Weld Rivers, from which point it is continued by a pack track to the Weld River at a point about three miles above the junction of the latter with the Huon, where a prospector named Fletcher has a lease and a hut. About 30 years ago a track was cut up the Weld Valley for about 10 miles, but this is now obliterated by horizontal scrub, and, although originally a well-made track, is useless in its present state. On the Tyenna-Port Davey track just east of the 14-mile hut is a notice "To Huonville 54M." This is a dangerous signboard, as there is no vestige of a track for the first ten miles, and the country is under heavy timber and dense scrub.

The old Craycroft track, a possible means of access to the Huon Plains, is reported to be quite obscured. The Valley of the Huon to the vicinity of its junction with the Anne River, and thence across the open plateau lying to the south of Mt. Anne, is a possible line of approach, but in the absence of any other cut tracks the route from Tyenna along the Port Davey track at present presents the fewest difficulties.

(c) Routes followed when the Investigations here recorded were made.

In December, 1920, Major L. F. Giblin and Mr. A. V. Giblin, with Messrs. V. C. Smith, J. Walch, and F. Steele, proceeded along the Tyenna-Port Davey track. Pack horses were got up to where the track debouches on the Huon Plains. The party made their main camp at the Huon crossing, but were here hampered by wet and misty weather. However, they accomplished the ascent of the Mt. Anne plateau, going by the southern of the two western spurs.

In December, 1921, the Messrs. Giblin, with a party consisting of Messrs. H. Hutchison, W. F. D. Butler, V. C. Smith, J. Walch, H. Kelly, H. Cooper, A. Hackett, V. E. Chambers, and the writer, endeavoured to reach Mt. Anne via the Weld Valley from the Huon. The party forced its way up the Weld Valley through horizontal scrub for three and a half days, reaching a point about 18 miles from its junction with the Huon, and then for another day up a large tributary flowing from the west, until a bare hill was reached. It was then seen that it would still take some days to reach the mountain, and the party was compelled to turn back. Great difficulty was experienced throughout the

trip in cutting through the heavy scrub, carrying heavy loads. This route would be quite impossible in a wet season.

In December, 1922, the same party, with the exception of Messrs. Butler, Cooper, and Hackett, and with the addition of Dr. L. McAulay, made a further attempt, this time by the Tyenna-Port Davey track. The weather was almost continuously bad, and only one fine day was experienced. The pack horses could not be taken more than a mile beyond Mt. Bowes, and the party had the greatest difficulty in crossing the many flooded feeders of the Huon. The main camp was made under the second westerly spur of Mt. Anne. Several attempts were made to get round or across the third (south-westerly) spur in order to reach Lake Judd, but heavy scrub intervened, and it appears that the easiest access to the lake would be by a long circuit by Lake Edgar and the northern end of the River Anne gorge. On the one fine day Mt. Anne was ascended by the second westerly spur and the plateau examined. Messrs. Hutchison and Chambers attempted to ascend the pinnacle, but were stopped by a virtual face about 30 feet below the summit, which had blocked an attempt by the 1920 party.

(d) Previous Literature and Acknowledgments.

No detailed account of the district can be found. In 1874 the late Mr. R. M. Johnston, when exploring the Arthur ranges, does not appear to have crossed to the east of the Huon. In 1880 Mr. Henry Judd, of the Huon, after several attempts in earlier years, succeeded in penetrating the scrubs of the Weld Valley and reaching the plateau of Mt. Anne. He discovered and named Lake Judd, and has left a brief but vivid account of the remarkable features of the lake and the great north-eastern gorge in a little-known pamphlet dealing for the most part with quite other matters (Judd, 1898). In 1908 the late Mr. W. H. Twelvetrees and the late Mr. A. S. Atkins were engaged in a geological exploration of the country between Tyenna and the Gordon, but their investigation only extended to the north of the area described in these notes. Mr. Atkins ascended Mt. Anne, and there is a brief reference to it in Mr. Twelvetrees' report (Twelvetrees, 1908). In 1920 Mr. A. McIntosh Reid covered the area described by Mr. Twelvetrees, during the investigations for his Bulletin "Osmiridium in Tasmania," and added more information, with a very complete geological map (Reid, 1920). Mr. Renison Bell and other prospectors

visited the district during the 90's, but no written reports can be found.

The present writer had the plans of Mr. Twelvetrees and Mr. Reid with him on the 1922 trip, and made full use of them as far as they extended.

The writer also wishes to acknowledge his indebtedness to all the members of the parties for the assistance rendered throughout the trips, to Sir T. W. Edgeworth David for his kind encouragement and suggestions, and to Colonel D. A. Lane for assistance rendered in drafting the plans accompanying this paper.

2. PHYSIOGRAPHICAL GEOLOGY.

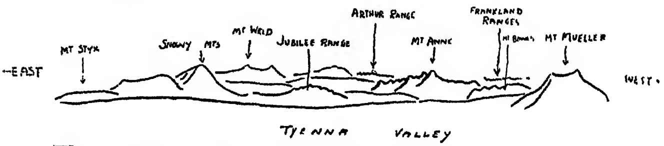
(a) Present Topography of Area.

The north of the district in question is marked by the line of elevated country extending from Mt. Mueller (about 4,000 feet) on the east about ten miles westward to Mt. Wedge (about 3,500 feet) and produced for three miles southward by the bold outlier, Mt. Bowes (2,500 feet). These hills form the watershed between tributaries of the Gordon, Derwent, and Huon Rivers. The valley of the Weld, which runs through the centre of our area, the divide between the Weld and the Huon, and the north-eastern portion of the valley of the Huon make up the area here described.

The Weld rises in many small streams in the centre of the range above mentioned between Mt. Bowes and Mt. Mueller. It is separated from the Styx for the first few miles of their courses by a watershed consisting of a confused series of small ridges densely covered with forest, among which it is difficult to tell which river many of the streams ultimately reach. The Styx, after flowing a few miles in a south-easterly direction, bends to the east, and passes out of the area with Marriott's Look-Out and the hills south of Tyenna on its north bank, and the Jubilee Range, Snowy Mountains, and Mt. Styx in succession on its south side. To the west the watershed of the Weld is separated from that of the Huon first by Mt. Bowes and then by a scarcely perceptible ridge joining that mountain to Mt. Anne, and farther south by the Mt. Anne range.

The Weld flows in a south-easterly direction for about twenty-five miles, the first five of which are through a broad valley with numerous insignificant ridges. Opposite Mt. Anne its course becomes a tremendous gorge with precipitous, scrub-covered sides rising to the eastern spurs of Mt. Anne on the west, and to the Jubilee Range on the east.

The valley opens out a little between Mt. Anne and Mt. Weld, and then narrows as the river runs between Mt. Weld and the Snowy Mountains in a steep-sided valley over 3,000 feet deep. For the three miles before its junction with the Huon it runs through a broad alluvial plain. The river consists of long deep pools separated by series of rapids. The river is difficult to cross throughout the lower half of its course, and appears liable to floods. It is one of the finest rivers in Tasmania, with a very considerable flow of water, and the scenery along the quiet reaches rivals that on the Gordon. A fine view of the valley of the Weld, which compares favourably with the gorges of the Forth and Mersey in the North, may be obtained from the slopes of Mt. Bowes.



The eastern side of the valley of the Weld is formed by the Jubilee Range and the Snowy Mountains, both running roughly north and south from the Styx Valley to the Huon, the Jubilee being about 10 miles long and lying west of the northern and less elevated extension of the Snowy Mountains. The Jubilee Range is a line of sharp, partly isolated, quartzite peaks, displaying the rugged outline and bare, precipitous flanks usual in these earlier Palæozoic ranges. It averages about 3,000 feet high, and when opened up will prove one of the most picturesque pieces of mountain scenery near Hobart. The Snowy Mountains are more elevated, but round in contour, as is the case with most of our diabase mountains. Their summit is roughly east of the summit of Mt. Weld, and their western slopes are broken by cliffs and huge talus slopes.

The Huon rises in the forest-covered southern slopes of Mt. Wedge and flows in a generally southerly direction to the south in a series of considerable bends and loops through a flat, swampy, buttongrass plain in places ten miles broad and clearly of glacial origin. The plain is continued to the north-west to Lake Pedder and the Serpentine Valley, and in places the flatness of the country makes it quite impossible to fix the location of the Huon-Gordon divide. The Huon, 20 miles south of Mt. Wedge, turns sharply to the east and ultimately joins the Weld, which thus becomes one —and probably the most considerable—of its tributaries.

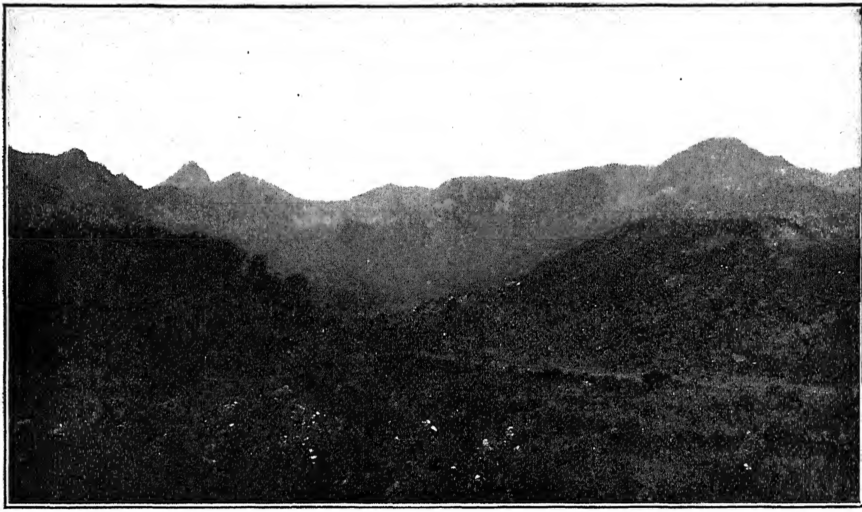


Fig. 1.

MT. ANNE RANGE FROM THE WEST.

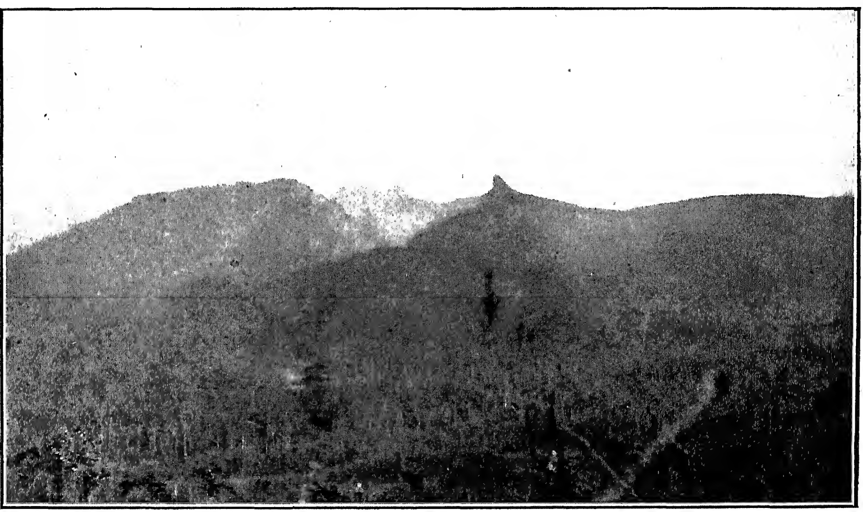
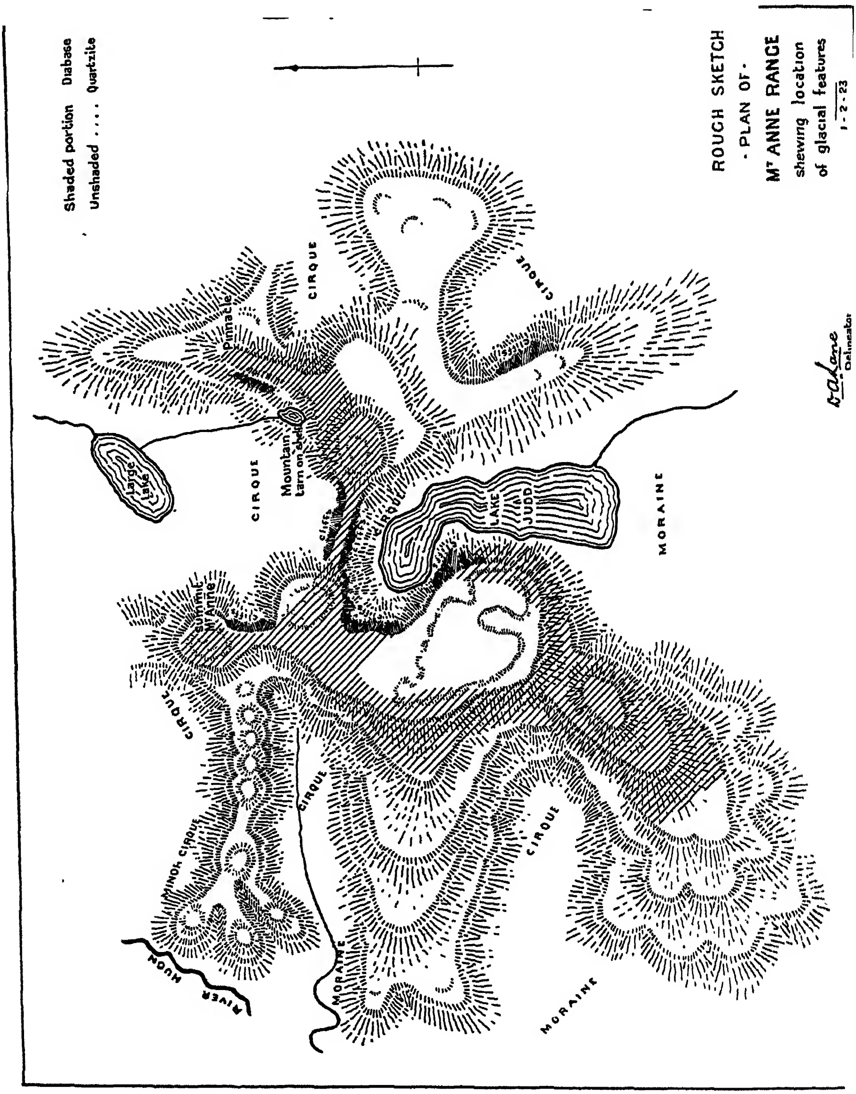


Fig. 2.

THE MT. ANNE RANGE FROM MT. WELD.

(A. N. Lewis, photo.)



SKETCH PLAN OF MT. ANNE.

The country between the Huon and the Weld is rugged in the extreme. To the north is Mt. Anne, a narrow ridge running roughly north and south, perhaps four miles long, with the summit at the extreme northern end standing several hundred feet above the ridge of the mountain and over 4,500 feet above sea level. From the summit the mountain drops steeply to the north, north-west, and north-east, so that viewed from Mt. Field or any mountains to the north it appears as a fine pointed cone rising straight from the plains and far higher than any other of the mountains of the south-west.

Lower spurs radiate on every side. To the north, the least significant connects the mountain with Mt. Bowes. On the west two ridges run out to the Huon. The more northerly is a rugged chain of peaks, about 3,000 feet high, steep on all sides and precipitous on the north-west. The sky-line of this ridge is very picturesque. The second ridge runs parallel to it about a mile and a half farther south. The contour of this ridge is smooth and rounded, but the sides are nevertheless steep. A couple of miles farther south and running south-west from the corner of Mt. Anne is a third spur, shorter than the other two, but broken into a number of ridges covered with undergrowth, which extend in a series of low, broken, but steep hills for some miles towards Lake Edgar.

Behind this ridge lies Lake Judd, perhaps two miles in length and half a mile wide, resting in a kidney-shaped cirque which has been carved out of the very heart of the mountain. East of the head of Lake Judd stands another peak only a few hundred feet lower than the Mt. Anne plateau, to which it is connected by a jagged comb ridge circling round the north end of Lake Judd. From this peak several spurs radiate. A short one to the south-east forms the other side of the Lake Judd cirque, and is again cut into on the south-east by another cirque. A second spur appears to connect this peak with a flat-topped and isolated plateau which forms the south-eastern buttress of the Mt. Anne range, and is bounded on the south by the last mentioned cirque and on the north-east by another cirque. Farther north a third spur radiates to the east, stretching out several miles to the Weld Valley. On the end of the higher portion of this is a peculiar pillar of rock, standing several hundred feet above the level of the top of the main ridge in a tower only a few dozen feet in diameter, and forming the most conspicuous landmark of the range. It is one of the

most remarkable mountain features in Tasmania, and the Messrs. Giblin appropriately named it "Lot's Wife." To the north of this spur is a very considerable precipitous walled cirque, in which lies a large bush encircled lake, not far from the Weld River.

South of Mt. Anne runs a long, rugged, but comparatively low quartzite plateau deeply dissected by gorges and occupying most of the country between Mt. Anne, Mt. Weld, and the Huon. It is separated from Mt. Anne by a deep, narrow, but flat-bottomed valley drained on the west by a stream flowing into Lake Edgar in the Huon Plains, in the centre by the Anne River, into which Lake Judd drains, and on the east by a considerable tributary of the Weld which has been named "Judd's Reward Claim Creek" from an old claim situated on its bank.

On the wall-like face of this plateau opposite Mt. Anne can be seen one large and three smaller mountain tarns, for the largest of which the name Smith's Tarn has been suggested, after Mr. V. C. Smith, who, of our parties, first saw it. The Anne River cuts through the plateau in a deep gorge. The plateau extends eastward to Mt. Weld, which eminence rises a thousand feet or more above it and forms its eastern buttress on the edge of the Weld Valley. Mt. Weld is over 4,000 feet in height and stretches for about eight miles, a narrow flat-topped ridge, ending precipitously at its northern end, and appearing an isolated peak when viewed from the north. It descends on the east very steeply to the Weld and on the west also steeply for a thousand feet or so to the level of the quartzite plateau. On the south its ridges reach to the Huon Valley.

(b) Development of Present Topography.

The present cycle of erosion in Tasmania dates from the time of the diabase intrusions, and it is difficult on the evidence at present available to be certain of conditions during the earlier ages. There is undoubtedly evidence of an old peneplain, lying between the Weld and Huon Rivers, formed in the Cambro-Ordovician strata prior to the diabase intrusions, and probably during late Devonian or early Permo-Carboniferous times. This peneplain is now much dissected by fluviatile and glacial action, but looking south from Mt. Anne the remarkable flat top of the quartzite plateau between Mt. Anne and the Huon catches the eye at once. The fact that the top of this stands at the same general level as the top of the quartzite under Mt. Anne, under Mt. Weld, under

Mt. Wedge, on the sides of Mt. Mueller and the exposed summit of Mt. Bowes, indeed of all the rocks of this series in the locality, points to the conclusion that these must all have once formed the top of a plain. Farther south and west the peaks of the Arthur and Frankland Ranges consisting of the old Pre-Cambrian schists have a remarkable accordance in altitude, suggestive of an ancient peneplain, but whether of the same or an earlier cycle of erosion is a problem for the future. There is no evidence at present upon which to fix the date of the peneplanation of the Cambro-Ordovician rocks of the area, but it was certainly earlier than the Permo-Carboniferous glaciation.

The diabase intrusions raised the sediments that had been deposited from the western lands in the coastal seas of Jurassic times and earlier and instituted our present cycle of erosion, but the extent to which the land to the west was affected by these intrusions or earlier and later earth movements and whether the older rocks of the West Coast were ever covered by the Trias-Jura sediments is not yet known. The diabase, however, certainly did force its way through the older quartzites in places, as at Mt. Anne.

The direction of the present drainage was probably determined by the landscape immediately after the diabase intrusions, during the Upper (?) Cretaceous. The rivers are therefore here, as throughout Tasmania, subsequent streams. The fact that the diabase with incumbent sediments rose to a height of 4,000-6,000 feet above present sea level, while the top of the older rock to the west now does not exceed 3,000 feet, yet the rivers run from west to east cutting, from the comparatively low lands of the west, in huge, steep sided valleys and gorges through the mountain systems that now stand highest, indicates that in Cretaceous times the mountains to the west stood, or were covered with other rock, since removed, which stood, twice as high as they now are to be seen—e.g., the Huon could reach the sea from its point of origin by several channels that do not rise over 1,000 feet, but it appears to cut through a ridge between Mt. Weld and Mt. Picton, 3,000 feet higher. It thus provides a good example of a subsequent stream being kept in its course by its original channel, formed in very different strata (in this case probably Trias-Jura sandstones) from those lying below, which now stand out as mountains of circumerosion.

The Huon, Weld, and Serpentine Rivers are on the verge of maturity although their tributaries are, as usual

in Tasmania, typical of juvenile drainage. The main streams have cut through the diabase sill and extended their valleys considerably in the softer rocks below. They have thus captured the drainage of very considerable areas of country, and in widening their valleys have isolated remnants of the old plateau which stand out as erosion residuals, Mt. Anne being one of the best examples of this type of mountain in Tasmania. [Sir Edgeworth David has asked whether the topography has been all caused by differential erosion and suggests faulting as responsible for the escarpments east of Mt. Anne. The writer had this possibility in view, but could find no evidence of large scale faulting, and respectfully submits that erosion is responsible for the present topography. But the possibility of a fault scarp running up the west side of the Weld, past Mt. Stephen (Tim Shea), west of the Vale of Rasselas, and even to the west of the Cradle Plateau, should be borne in mind in future investigations.] In eroding their valleys the rivers have removed later sediments from and exposed the early Palæozoic topography, which, as Mr. Ward has remarked, is now exerting an influence on present topography (Ward, 1909). An interesting example of this is to be seen at the mouth of the Weld, where several miles of Cambro-Ordovician quartzites with an already developed topography are being exposed from beneath the sandstones. The topography of the western portion of the area has been moulded by glaciers during the Pleistocene Ice Age, the work of which will be dealt with later. The rivers are at present engaged in removing the morainal dams of the lakes and other remains of the glaciers.

3. STRATIGRAPHICAL GEOLOGY.

(a) Pre-Cambrian.

The highly foliated quartz-mica schists, ordinarily referred to the Proterozoic [the Algonkian of Ward and Twelvetrees], with which the Arthur and Frankland Ranges are made up do not appear to cross to the east of the Huon unless Scott's Peak [which was not examined] consists of these rocks, but this is unlikely. Mr. R. M. Johnston in his Geology of Tasmania placed the rocks of the western ranges in this system, and Mr. Twelvetrees describes the junction with the quartzites visible north of Mt. Wedge (Twelvetrees, 1908), but in the area being described the junction appears to be obscured beneath the glacial deposits of the Huon Valley. The Geological Map of Tasmania issued by the

Geological Survey in 1914 shows the eastern boundary of the Pre-Cambrians here from 3 to 5 miles too far east.

(b) Early Palæozoic.

Rocks of this age predominate in the area. They consist of massive and extremely hard quartzites with occasional beds of slate and conglomerates. The age of these beds, which occur considerably in south-west Tasmania, is not definitely fixed. They are to be seen overlying the Proterozoic (Twelvetrees, 1908) and at Tim Shea, the Needles, and the Thumbs they underlie beds of West Coast Conglomerate, now known to be the base of the Silurian (G. A. Waller 1904, Loftus Hills 1921) which cap these peaks. Beds of limestone occur south-west of Mt. Mueller, and these can be seen to be overlying the quartzites. Mr. W. S. Dun considers these limestones (Gordon River series) from palæontological evidence to be undoubtedly members of the Silurian system, and these beds of quartzite, allotted by R. M. Johnston, Twelvetrees, McIntosh Reid, and others, to the Cambrian, appear certainly to be Pre-Silurian. For the present Cambro-Ordovician appears the most correct classification.

On the east side of the Huon every eminence protruding from the glacial plain consists of quartzites of this age, always inclined at a high angle and in massive layers separated at intervals by thin layers of more flaky rock. Time did not permit of the working out of the details of the stratigraphy of these beds, but almost every outcrop showed a different angle of dip. The colour is generally white, but often tinged with pink. The cliffs to the north-west of the more northerly of the two western spurs of Mt. Anne show a beautiful salmon-tinted shade visible from some distance. On the western side of Mt. Anne the quartzite is dipping at an angle of about 50 degrees in a direction about 45 degrees W. of N. The quartzite is traversed in all directions by veins of white quartz, often over an inch in thickness.

The quartzite extends under the diabase cap of Mt. Anne, which is about 1,500 feet in thickness. Perched on the top of the diabase is another small layer of quartzite. This will be commented on later when dealing with the diabase. The quartzite can be seen emerging from under the diabase on every side of the mountain, and is continued southward at least as far as the valley of the Huon, comprising the plateau mentioned as lying south and south-east

of Mt. Anne and extending eastward until obscured by the diabase of Mt. Weld.

South-east of the latter mountain it emerges again in a small outcrop round the mouth of the Weld River, where it forms a low line of hills some three miles long on the west side of the river, and on the east of the Weld a number of isolated cone-shaped, buttongrass covered hills known as "Glover's Paddocks." The quartzite is here dipping at an angle and in a direction similar to the beds on the west of Mt. Anne. Five miles up the Weld from its junction with the Huon the older quartzites disappear under Permo-Carboniferous and Trias-Jura sediments, which also cover the older rocks to the east and form the divide between the Weld and Denison Rivers. To the west it is obscured by the diabase of Mt. Weld.

At a spot some twelve or fifteen miles up the Weld the older rocks again appear in the bed of the valley, stretching right across from Mt. Anne to the Jubilees and northward to the head of the river. The Jubilee Range appears to consist of the same massive white quartzites, which, however, do not extend farther east than the foot of the Snowy Mountains. To the north, similar beds compose Mt. Bowes and the southern foothills of Mt. Mueller. On Mt. Bowes the quartzite is dipping at an angle of about 60 degrees a few degrees south of west.

On the west of Mt. Bowes are large beds of a hard reddish slate resembling burnt fireclay, which appear to be included in the quartzite beds. In the course of the Weld roughly 12 miles from its mouth are considerable beds of grey slate resembling in general appearance the Dundas slates of the West Coast (Cambro-Ordovician), but no indication of its exact horizon was found. Opposite the end of the Jubilee Range there is a small outcrop of serpentine or serpentinised rock to be seen in the bank of the river. It is overlying unconformably some beds of white sandstone which show no signs of contact. On the old track just above this outcrop is a corner peg blaze apparently of an intended claim, but no application was ever lodged. A bed of grey slate of small extent lies across the Port Davey track to the north-east of Mt. Bowes near the old Junction Huts.

The older rocks extend eastward in the Russell Falls River Valley as far as Pine Hill, three miles west of Fitzgerald Station. (On the beforementioned Geological Map they are shown as extending some eight miles too far east in the Tyenna Valley). They are overlain to the north

and east by Permo-Carboniferous mudstones, to the west by basal conglomerates of that system, and to the south they are separated from the similar rocks of the Jubilee Ranges by ridges of diabase. They appear to underlie the diabase throughout the whole area and to be exposed when the valleys have been eroded sufficiently deeply. The writer is inclined to think that the area shown on Mr. Reid's map as occupied by Permo-Carboniferous sediments is too extensive, and that most of this country, except on the south-eastern slopes of Mt. Mueller, consists of older quartzites. The quartzites outcropping on the road to Mayne's Farm at the base of Pine Hill is streaked with veins of quartz containing quantities of iron pyrites.

As indicated on Mr. Reid's map and on the sketch accompanying this paper, two beds of limestone occur in the valleys of the two northern branches of the Weld. This is a hard white rock of the Gordon River Limestone series (Twelvetrees, 1908). The writer can only confirm Mr. Twelvetrees' remarks on the occurrence, which should be referred to for a more detailed account of the country traversed by the South Gordon track.

(c) Permo-Carboniferous and Trias-Jura.

Sediments of this age appear along the eastern side of the area, the line of the valley of the Weld being approximately the present junction line between the newer and older rocks in this part of Tasmania. The base of the Permo-Carboniferous system consists of glacial conglomerates. Two small but excellent examples of this formation, which is so well developed at Wynyard, are to be seen in the area.

One of these occurrences extends from about a mile west of Fourteen Mile Creek on the Tyenna-Port Davey track, to the top of the Russell Falls River-Styx divide on the south-eastern spur of Mt. Mueller. The beds are exposed for three miles or so along the track. They consist of the typically grey, clayey matrix, showing little signs of stratification, and only just resistant enough to require the use of a hammer, studded with pebbles and boulders of all sizes, but chiefly smaller than a cricket ball, consisting of grey quartzite, quartz, slate, and mica-schist. There is a strange absence of red granite. Mr. Twelvetrees mentioned the existence of Permo-Carboniferous conglomerate here, but apparently did not recognise its glacial origin. The Pre-Cambrian mica-schist boulders reported by him from Fourteen Mile Creek were probably derived from this tillite. Mr.

Reid states that he knew it was tillite. The present writer found ample confirmation in the numerous ice-scratched pebbles which were found in greater profusion than at Wynyard, although, as at the latter place, large patches of the tillite occur in which no scratched pebbles can be found. The glacial beds seem to occur between the 1,400 and 1,800 foot contour lines, and appear to be overlain by beds of a coarse sandstone at a height of 1,800 feet above sea level, but neither its highest point nor its boundaries can be ascertained from the track. It rests, on both sides, on Cambrian quartzites.

The second occurrence of glacial tillite of this age was noticed in the course of the Weld about 15 miles from its mouth, at an altitude of about 500 feet. The river has cut through the morainal deposit, which is exposed on its bank. It is similar to the Wynyard formation and that just described, on Mt. Mueller. The proportion of red granite pebbles and boulders is high, and several erratics are of considerable size.

It may be worth noting, in passing, the fact that four occurrences of the rare Permo-Carboniferous glacial till, namely those at South Cape Bay, Wynyard, and the two described, lie in an almost straight line, which if produced passes near Bacchus Marsh in Victoria, where similar beds occur. This may be only a coincidence but it is a point to be borne in mind when investigating these beds.

These beds are succeeded by 300 feet of a coarse but regular conglomerate of Permo-Carboniferous age, resembling in general appearance the recent river drifts of the Derwent and elsewhere, and consisting of a hard yellowish matrix cementing together quartzite pebbles about the size of a cricket ball. Its age is definitely fixed by some strata that occur in its upper layers on the ridge to the east of the river and which contain fenestella. The conglomerate appears to be the river drift or delta deposit of some ancient river which perhaps flowed through the marked gap which now separates the Arthur and the Frankland Ranges and is continued east in the deep valley south of Mt. Anne and north of Mt. Weld.

Lower down the Weld, Permo-Carboniferous mudstones flank the valley. In the bed of the river they are the lower marine series and contain many of the typical fossils of those rocks. They flank the southern end of the Snowy Mountains and probably the eastern side of Mt. Weld. An outcrop of horizontal strata under the diabase organ pipes of the northern end of Mt. Weld could be distinguished from

Mt. Anne. This looked like rocks of this or the succeeding system, but their actual nature could not be confirmed. Here as elsewhere the Permo-Carboniferous mudstones are succeeded by the Knocklofty sandstones of the Trias-Jura.

The Russell Falls River is cutting through the upper marine series of the Permo-Carboniferous, which is traversed at intervals by bars of diabase and overlaid at about the 800 foot contour round the valley by Trias-Jura sandstones through which the river has cut and which are now nearly all denuded away, leaving the diabase of the hillsides bare. Elsewhere in the area, if the older rocks were ever covered by these sediments erosion has now removed all trace of them.

(d) The Diabase Intrusions.

The reader is referred to Mr. P. B. Nye's remarks on the occurrence of the Cretaceous diabase in his "Underground Water Papers, Nos. 1 and 2," undoubtedly the best account of the subject yet published. The area described in this paper would repay detailed study on this point.

In Tasmania the diabase appears to occur either in laccolith-like mountains of greater or less extent such as are common in the centre, east, and south, and of which the Central Plateau, Mt. Field East, and Mt. Wellington provide examples, and which may be distinguished by the immense beds of Permo-Carboniferous and Trias-Jura sediments hoisted up on their flanks, or, more rarely, as mountains isolated by erosion from a once extensive sill of diabase which spread over the top of early Palæozoic rocks, for example, Barn Bluff, the Eldon Range, and most of the more western diabase mountains (see The Geological Survey's publication "Coal Resources of Tasmania," 1922).

The Snowy Mountains, Mt. Styx, Marriott's Look-Out, and the diabase hills south of the Tyenna Valley are of the laccolithic type and probably are connected with the Mt. Wellington range intrusion. Probably diabase has covered beds of the older quartzites along the edge of the known occurrence of these, and this is undoubtedly the case on the lower Weld and west of Tyenna, but it is difficult at present to say where the main upthrust of the diabase occurred and where the sills joined the laccolithic intrusions.

Mr. Twelvetrees has classed the diabase of Mts. Mueller, Anne, and Wedge as portions of sills (Twelvetrees, 1908). This certainly appears to be the case in regard to Mt. Anne and Mt. Wedge, but Mt. Mueller and Mt. Weld seem rather to belong to the laccolithic type with extensions westward in

the form of sills. On the south-eastern shoulder of Mt. Mueller basal conglomerates of the Permo-Carboniferous appear at a height of at least 1,800 feet, while at Fitzgerald, six miles away, the top of the system can be seen at an elevation of 900 feet. This points either to a diabase uplift on the eastern slope of Mt. Mueller of at least 2,000 feet, or to a fault with a throw of that height running along the face of Mt. Mueller. In view of what has occurred throughout Tasmania it seems more probable that the diabase of Mt. Mueller has raised the tillite, with the quartzite that underlies it, to their present height. The diabase of Mt. Mueller appears to reach a low level on the north-eastern slope, but it does not appear to be connected with the diabase from the Mt. Field ranges, which extends westward in a broad sill now seen capping Field West, Tyenna Peak, the Knobs, and Wherrett's Look-Out. To the south-east the diabase of the hills south of Tyenna approaches, if it does not join, that of Mt. Mueller. To the west, the Mueller diabase appears to have extended over the quartzites in a sill in the direction of Mt. Wedge.

Mt. Weld is certainly a diabase uplift. There are considerable occurrences of diabase in the valley of the Weld between 5 and 10 miles from its mouth at a height under 300 feet above sea level, whence it appears to lead right to the summit over 4,000 feet above. Alongside Fletcher's Hut on the banks of the Weld the diabase can be seen penetrating the quartzites in a large dyke of very close-grained rock. To the west the diabase appears to extend for some distance in a sill over the top of the quartzites.

Mt. Wedge is crowned with a cone of diabase, apparently a portion of an old sill resting on the older quartzites, but the writer has no data at present on which to determine from which direction the sill originally came.

Mt. Anne is also capped with diabase, probably portion of an old sill. It lies on top of the highly inclined quartzites, and appears now to be 1,200-1,500 feet in thickness. The most interesting feature of its occurrence here is the existence on the top of the Mt. Anne plateau of a small area of quartzite, perhaps a square mile in extent and 100 feet thick. This is an almost unique feature in the Tasmanian occurrence of diabase. This mass of quartzite, which appears to be a remnant of the rocks through which the sill penetrated and which probably originally overlaid it, has either been lifted 1,500 feet from its bed by the intruding sill or has been sheared from the top of some mass of quartzite and been carried along by the diabase. As the

quartzite varies considerably from one locality to another it should be possible to discover whence this mass came, and the light such an investigation would throw on the mechanics of the diabase intrusions would well repay the trouble.

The diabase adjacent to the quartzite is of a glassy, homogeneous texture for about 100 feet, in which space it changes to the ordinary coarse-grained crystalline rock common on the mountain tops. This is interesting as showing conclusively that coarse crystals in the diabase are not an indication that the rock in question cooled at a great distance below the then surface. This close-grained diabase is sufficiently different in nature to be clearly distinguishable from the ordinary diabase at a distance of several hundred yards.

In the centre of the quartzite patch a small cirque has cut into it to a depth of about 75 feet, and in the centre of this depression can be seen a dyke of glassy diabase about 12 feet wide penetrating the quartzite. The junction line between the quartzite and the diabase is finely marked, but the former rock shows no signs of having been affected by the diabase.

The diabase cap of Mt. Anne has been greatly denuded by glacial action and has nearly disappeared. On the sides of the cirques that eat right into the heart of the mountain the junction between the diabase and the country rock it overlies can be clearly distinguished. There is probably no place in Tasmania in which the diabase intrusions can be studied with greater prospects of good results.

(e) Post-Diabase Sediments.

Since Cretaceous times this portion of Tasmania appears to have been enjoying sub-aerial conditions, and no signs of Tertiary sedimentary rocks were seen. A little Pliocene (?) basalt occurs at Mayne's selection, six miles west of Fitzgerald, as shown on Mr. Twelvetrees' and Mr. Reid's maps. Pleistocene glacial deposits litter a great part of the countryside. These will be described in the next section. Post-Tertiary alluvial deposits exist in the Russell Falls River Valley (Twelvetrees, 1908) and on the lower Weld, at the mouth of which there is a curious delta of alluvial material stretching some three miles up the river and three miles along the bank of the Huon, consisting of small, round, water-worn pebbles, chiefly of quartzite, and is more or less swampy ground. This appears to be a flood plain of the Weld, deposited as the swift current was slackened as it

debouched into the Huon Valley. As the Huon deepened its bed or the sea level altered, the Weld has cut through and partially drained this plain. An apparently similar, though more extensive feature occurs on the other side of the Huon, and is known as the Arve Plains.

4. GLACIAL GEOLOGY.

(a) Descriptive Account.

The western half of the area dealt with in this paper and all the mountain tops in it show evidence of intense glaciation during the Pleistocene. In the Upper Huon Valley between Mt. Wedge, Lake Pedder, Mt. Anne, and the Arthur Range, the whole topography has been moulded by ice action. The flatness of the plains, stretching, as they do, for ten miles and more in an almost level swamp, and the sinuous courses and sluggish currents of the streams indicate that these plains are not due to the erosion of the streams that now occupy them. A recent elevation above the sea could have produced such a landscape, but there is no evidence of any sufficient uplift or of marine deposits here, and it is not the still undrained top of a plateau, as it is surrounded by lofty peaks. The rivers starting their course as mountain torrents flow for several dozens of miles through plains in a very mature stage of erosion and then finish their course in a more or less juvenile stage. Clearly an "accident" has occurred to the drainage of the Huon and Serpentine Plains, which do not present the characteristic features of river erosion, and the cause of that accident has been the intervention of the ice sheets and glaciers of the Pleistocene glacial epoch.

The general aspect of the whole region, the sides of the hills rising in a clean curve nearly vertically out of the plain, the U-shaped gaps between adjacent hills when they occur close together, the absence of water-worn valleys in the extraordinary level plain, all support this view. Some low hills break the surface of the plain at considerable intervals. These are almost always narrow, steep-sided ridges, apparently scraped bare by ice. The lower slopes of the main mountains and spurs are in general smooth and decidedly concave in section—ordinary water-worn hills being convex, streams gathering strength to erode as they descend —while the more elevated crests are extremely rugged above the 3,000-foot contour with picturesque pinnacles and crags. The outstanding spur of the Frankland Range that rises to the south-east of Lake Pedder is decidedly Tind-like when viewed from Mt. Anne.

Fig. 3.

LOOKING SOUTH FROM THE SOUTH END OF MT. ANNE PLATEAU.

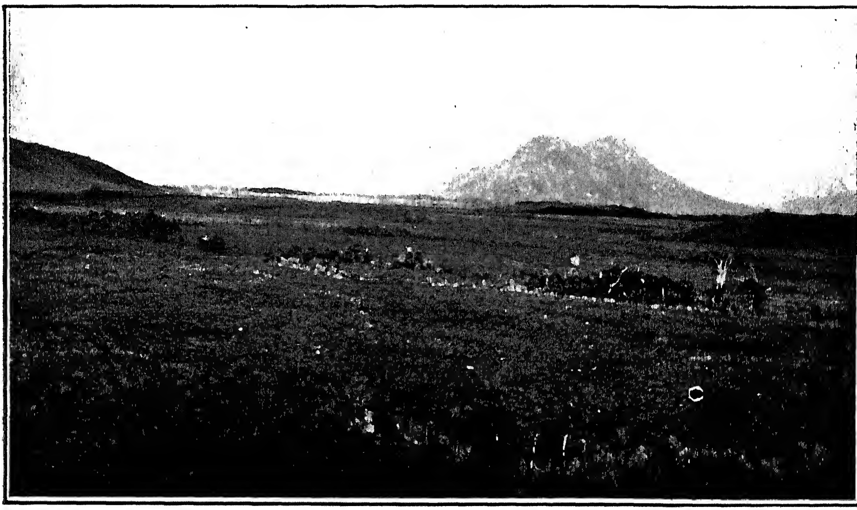


Fig. 4.

THE HUON PLAINS LOOKING WEST FROM THE S.W. OF MT. ANNE.

(A. N. Lewis, photo.)

All this can be seen at a glance when the landscape is viewed in panorama from an elevation and points to an invasion of the whole district as indicated, by a great ice sheet, probably 1,500-2,000 feet in thickness [the elevation of the rugged and apparently unglaciated crags above the floor of the glacial valleys], growing from the tremendous snow precipitation of the West Coast and moving down the Huon, Serpentine, and Anne River Valleys, and perhaps reaching the sea at Port Davey. An ice cap must cover the whole of the land surface of the area (Hobbs, 1910). It is doubtful at present whether the ice that filled the Upper Huon at this stage covered the top of the surrounding mountains with a continuous white sheet. The rarity of moraines definitely attributable to this epoch of glaciation is an indication that here at any rate very little rock surface was showing above the ice. But even if the more prominent ranges protruded it was a very considerable glacier bearing close resemblance to an ice cap, and the ice moved radially over the flat country between the ranges impelled rather by weight of successive accumulations of snow than by the slope of the ground. This ice cap carved the main features of the topography of these western plains before the advent of the glaciers, which have left us the more obvious traces, and which by the action of their cirques eating into the sides of the mountains have carved the present topography of the elevated mountain ranges.

These later glaciers have left remains that are easily recognisable all round Mt. Anne, which has been subjected to the biscuit-cutting process described by W. D. Johnson (Hobbs, 1910), and approximates to the topography he calls a "karling" (using Nussbaum's term) illustrated on Plate 8 of Hobbs' 1922 edition. The mountain has been cut to the heart by three tremendous cirques, in two of which lie considerable lakes dammed back behind walls of morainal material which covers the plain at the entrance to the cirques Other cirques have cut into the outliers on the south-east and west.

Between the two western quartzite outliers is a tremendous cirque, cutting into the mountain to the diabase cap and standing at the head of a decidedly U-shaped valley some three miles long. The cirque that terminates the valley had not started to enlarge at its head before the conclusion of the glacial period and the walls do not present as fine a circle of cliff as is common in Tasmania. The glacier that flowed from here has strewn the floor of the valley with

moraine in which diabase boulders alternate with quartzite ones. The moraine has not at any place completely dammed the valley, and there is no lake here. At the time this glacier was in the field several other ice flows must have moved a few miles out on to the plain from the numerous small recesses along the south-western face of the mountain. These have not left any well-defined cirques and could never have been extensive, but the plain near the foot of the mountain is littered with morainal material, amongst which diabase boulders are common, and these must have been carried some miles.

Apparently the crest of the more northern of the two western spurs stood out from the ice at this period, and the glaciers that flowed along each side have sapped back into the quartzite and produced a fine comb ridge. For the whole length of this spur its top culminates in a knife-like edge which the sapping effect of the ice has cut through at regular intervals, with the result that the top is crowned with a series of pinnacles rising precipitously 100 feet or more from the general line of the summit of the ridge. Its northern face shows some fine ice sculpturing, and is cut by several cirques. The Port Davey track skirts the foot of an escarpment 1,000 feet in height that appears to be a cirque wall. The end of the spur is divided into several minor features by cirques that have cut deeply into it and have, by enlarging their heads, thrown into relief the rock sentinels at the entrance to the cirques described by Professor Hobbs (Hobbs, 1921) which now stand out as quite prominent peaks. The second spur appears to have been under the ice for a long period and possesses a round contour without cliffs or irregularities, which anyone ascending the mountain finds to be a great advantage.

Farther to the south lies the Lake Judd Cirque, which, commencing at the south-west corner of the mountain, has eaten right into the centre of the pre-glacial plateau and nearly meets the western cirque just described. It is a fine example of this glacial feature, that to such an extent makes our mountain scenery. The floor of the cirque is almost entirely occupied by Lake Judd, a handsome sheet of water, perhaps two miles in length and a half a mile wide, crescentic in shape and set in the very heart of the mountain, with cliffs probably 2,000 feet high rising on three sides almost vertically from its waters. To the north-east and the south-east the cirque has enlarged its basin until it has met other cirques and eroded the entire pre-glacial surface

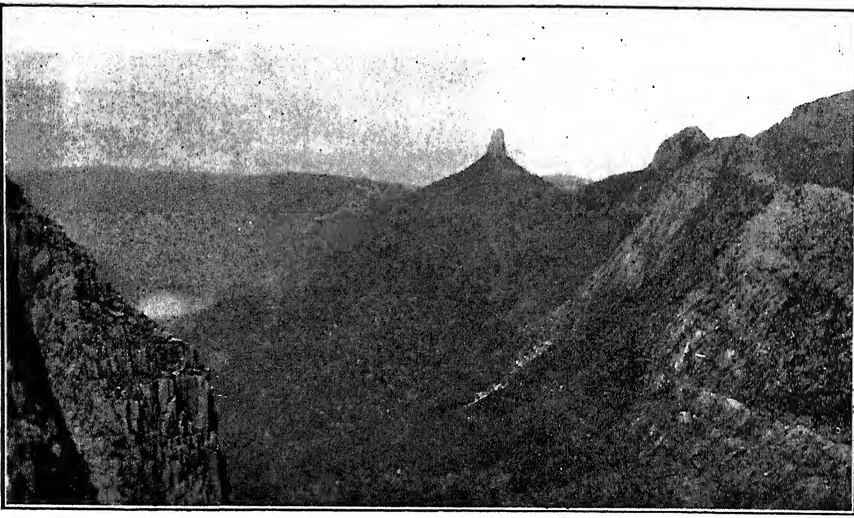


Fig. 5.

LOOKING EAST FROM NEAR THE SUMMIT OF MT. ANNE.

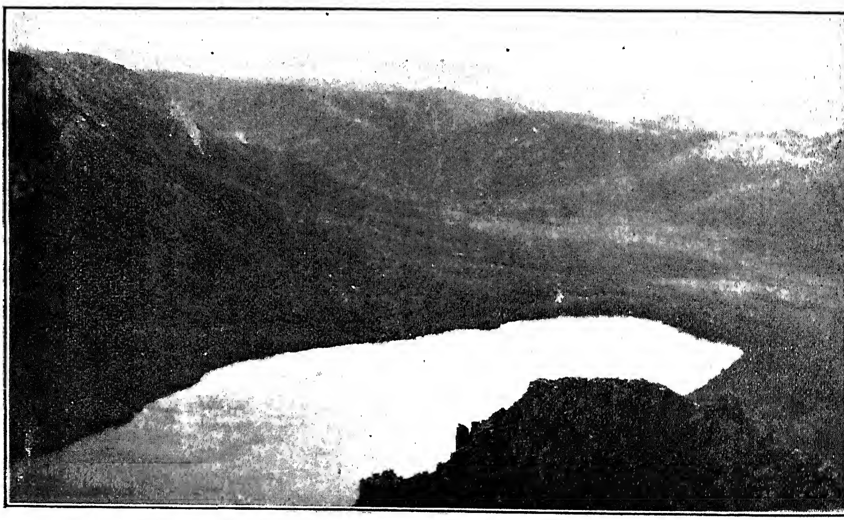


Fig. 6.

THE WESTERN END OF LAKE JUDD FROM THE MT. ANNE PLATEAU.

(A. N. Lewis, photo.).

of the plateau. The cirque wall now terminates in a unique example of a comb ridge, so precipitous and jagged that it would defy experienced climbers to traverse it. Impounding the lake is the most pronounced moraine in the locality. For a mile or more the country between the shore of the lake and Lake Edgar in the Huon Valley to the south-west and the Anne River to the south-east is covered with the confused succession of ridges and hollows typical of terminal morainal country so admirably described by Mr. A. McI. Reid (Reid, 1919). Lake Judd closely resembles Lake Seal in the National Park and Lake Dove on Cradle Mountain, but is a grander piece of scenery than either of these.

To the east of Mt. Anne is the most extensive cirque in the district. It appears to be deeper and is certainly broader than the other two mentioned. Its western wall must descend in a series of sheer precipices for 3,000 feet to the level of the Weld Valley, where lies a forest-encircled lake perhaps half a mile long, presumably of glacial origin. This cirque has eaten through the plateau until it has just met the western cirque and has carved out the other side of the comb ridge at the head of the Lake Judd Cirque. The size of this cirque gives another example of the general rule that the maximum snow action occurs on the lee of the ridge—in Tasmania, the eastern side. This cirque is a composite one with two main lobes and many smaller sub-divisions. In its south-west corner it meets another cirque that has grown from the south-east of the mountain. Between these two cirques is a second comb ridge, somewhat shorter but as rugged as the one before described. This forms the summit of a long diabase spur at the end of which stands the peculiar feature that has been named "Lot's Wife," mentioned earlier. This pinnacle, standing many hundred feet as perpendicularly and straight-sided as a tower, is a striking example of a glacial horn. It has grown at the entrance to two cirques, which, enlarging their heads behind it, have removed the entire top of the pre-glacial spur to a depth of some 500 feet and left this pillar of rock standing at the end of the dividing ridge, the uneroded remnant of the pre-glacial spur with its summit representing all that is left of the original surface.

On the south-east side of the mountain there are two considerable cirques, the one mentioned above which has met the eastern cirque, and the other a mile farther west which has left a narrow ridge separating it from the Lake

Judd Cirque and a plateau of quartzite between it and the former of this pair. Between these two cirques, the Lake Judd Cirque and the one on the eastern side of the mountain, is a peak which provides a good example of a young glacial horn. The cirques have met or all but met all round it and have started to cut down the comb ridges, leaving this mass of mountain standing well above the surrounding cols, which are in process of being lowered, although the process was not a quarter of the way towards completion when the glaciers vanished.

These glaciers ended where we now see their terminal moraines, but the water flowing from them carried much material with it. To the east this was washed down the comparatively rapid Weld to the sea, but to the west the many streams emerging from the glaciers' ends spread their deposit over the flat plain already in existence, caused by the previous ice invasion. They thus formed large areas of glacial outwash aprons. It is these masses of rock and gravel strewn by numerous glacial streams over the older glacial valleys that form the great buttongrass plains of Western and South-Western Tasmania.

High up in various parts of the plateaux at about the 4,000 feet level and a little higher are several small cirques, some containing mountain tarns. These are evidently due to glacial action as described in the Field Ranges by Professor Griffith Taylor (Taylor, 1921). On the top of the main plateau there is a very perfectly formed and easily recognisable pair of cirques eating into each side of the quartzite patch before described and nearly cutting it in two, and several lakelets are to be seen to the south-east of the head of the Lake Judd Cirque.

A few other evidences of past glacial action were observed. To the south of Mt. Anne on the face of the quartzite plateau opposite the mountain could be seen four small tarns, the largest of which, as has been mentioned, has been called Smith's Tarn. These are all of glacial origin and are splendid examples of small cirques, Smith's Tarn rivalling the (so-called) Crater Lake on Cradle Mountain. The ice descended by a rock stairway to the basin of the tarn a few hundred feet below it, and thence probably to the valley of the Anne River.

The old moraine from Mt. Mueller noticeable from the Port Davey track is described by Mr. Twelvetrees (Twelvetrees, 1908), and although evidence of glacial action is not otherwise obvious, the glacial theory of the origin of this

deposit seems reasonable. There are indications of a young cirque on the south-western corner of the summit of Mt. Mueller, and glacial action would be expected here at an elevation of 3,000 feet at least. Probably ice more resembling an ice cap than a glacier radiated across the spurs and adjacent plains of Mt. Mueller. Mt. Weld and the Snowy Mountains have the altitude and the area to provide névés for glaciers. From information given by some prospectors there is a marked glacial shelf on the eastern side of Mt. Weld on which repose some mountain tarns, and on the Snowy Mountains there are several lakes, one at least of considerable size.

(b) Glacial Epochs in Tasmania.

In the Northern hemisphere it is definitely established that, during Pleistocene times, the ice sheets descended four times over considerable portions of the continents of Europe, Asia, and America. These glacial invasions are known in Switzerland respectively as the Gunz, Mindel, Riss, and Würm ice ages, and are separated by inter-glacial periods of temperate climate. If conditions were similar for both hemispheres—as is the present theory—and if the temperature was sufficiently cold during each of these periods to cause glacial conditions as far north as Tasmania we should find signs of four corresponding invasions amongst our glacial remains.

Recently the Director of the Geological Survey, Mr. Loftus Hills, made the important discovery of the track of a very old glacier in the Pieman Valley. He has told the writer that glacial pavements formerly considered to belong to the Permo-Carboniferous glaciation were really caused by ice during the Pleistocene, but at a date far anterior to the more obvious signs of glaciation on the West Coast range. His opinion was confirmed by Sir T. W. Edgeworth David after a visit in March last year. Later, Mr. Hills has informed the writer that he found signs of two distinct glaciations in the vicinity of Lake Augusta at the head of the Ouse, where one moraine appears superimposed on another, with a peaty deposit from an intervening inter-glacial period between the two glacial deposits. Observations collected in the National Park indicate the existence of three ice invasions (Lewis, 1921). This idea has now been strengthened by additional data collected around Mt. Anne and the kindly confirmation given by Professor Sir T. W. Edgeworth David, our universal friend and helper.

It now appears that during the Pleistocene times we have traces of three ice invasions. The earliest apparent one was by far the most considerable, and was followed by two later phases. The writer suggests that this would correspond with the Mindel ice sheet of the Northern hemisphere. The size and intensity of this have obscured, if not obliterated, the traces of the Gunz in Tasmania, if any ever existed. The succeeding ice invasions may correspond with the Riss and Würm respectively. This theory is not yet proved, but may be useful as a working hypothesis. The finding of definite traces of interglacial periods between the various morainal deposits is necessary for the proof of the theory.

In the Mt. Anne region, in the National Park, and in Cradle Valley and elsewhere in Western Tasmania, there is every reason to believe that the obvious moraines are deposited on the top of a previously formed glacial topography. The regularity with which lakes appear in pairs, one superimposed on the other with, occasionally, mountain tarns at a greater altitude, the fact that this arrangement is never exceeded, and the definite signs of an older and a newer glaciation mentioned before, are indications that the apparently superimposed deposits are not merely a later phase in a receding cycle of glaciation, but are due to separate invasions. This contention, however, still remains to be proved.

If it will be borne out by future investigations the history of the Pleistocene glaciation in Tasmania will be in general this: The traces of the Gunz glaciation have been obliterated. During perhaps Mindel times a tremendous ice cap covered the western and south-western highlands and the more elevated portion of the central plateau. In the west the ice descended nearly to the sea. It covered, and so protected, the higher mountains, but moved down the valleys and out from the edges of the cap in great glaciers which, as Sir Edgeworth David has informed the writer, have left great outwash deposits in the vicinity of Strahan, and were responsible for the old glacial pavements of the Pieman, and the big terminal moraine seen at 13½ miles from Strahan on the railway track to Zeehan. Lake St. Clair was possibly a cirque formed at the head of a glacier growing from this ice sheet, which then filled the Cuvier Valley and covered the surrounding hills. Farther east, as at Cradle Mt. and Mt. Field, the ice cap covered the summits of the higher ranges but did not

reach the bottom to coalesce with ice from neighbouring hills; for example, the Florentine Valley formed a gap of several miles between the ice cap of Mt. Field and the ice in the Vale of Rasselas. On these mountains the ice moved for some distance down the pre-glacial valleys, leaving its imprint on the topography. During this invasion the ice cap spread far out over the central plateau, being responsible for the many lakes and tarns between Cradle Mountain and the Ouse, and most probably responsible directly, or indirectly through the action of the intense cold on the rocks of the plateau, for the origin of the basins in which the Great Lake, Lake Echo, and Lake Sorell lie. It is possible that these are rock basins scooped by the ice sheet, but there is at present no direct evidence to couple their origin with ice action. The small glaciated areas on Mt. Wellington and Ben Lomond possibly belong to this period, and there are indications that many of the mineral-bearing drifts of the north-eastern highlands are glacial outwash fans. The characteristic remains of the possible Mindel glaciation in Tasmania are the broad flat plains throughout the western parts that are generally known as buttongrass plains.

At present we do not know anything about interglacial epochs, but following this period came the invasion by the Riss glacial epoch. Conditions were far less severe than during the Mindel times. The more elevated regions only were affected. Valley glaciers of the Dendritic type (Hobbs, 1910) grew from névés on the ranges and crept a short distance down the mountain valleys. These glaciers are responsible for the great cirques that contribute so much to our finest mountain scenery. As a rule the glaciers did not debouch far from their mountain valleys. They spread great deposits of moraines over the plains surrounding the valley mouths and for some distance up the valleys themselves, where morainal banks frequently dam back fine sheets of water. Between the cirques and U-shaped glacial valleys there still remains much of the older surface showing the rounding effects of the older Mindel ice cap. The glaciers occurred during this period on all mountain ranges in the western half of Tasmania over an elevation of 3,000 feet, and near the coast evidently reached much closer to sea level. The cirques and moraines of Lake Judd, Lake Seal in the National Park, Lake Dove in Cradle Mountain, and all the more striking signs of glacial action belong to this Riss period, which may be termed the cirque-forming period. The rounding effect of the Mindel ice sheet and the cirque-form-

ing effect of the Riss glaciers have left almost contrary results on our glacial topography.

Following this and clearly superimposed on it come the relics from the Würm glaciation, typified by the mountain tarn. The period of glaciation was this time far less intense than during the Riss period. Only the tops of the more elevated mountains were affected, and the nivation line appears to have rested at an elevation of about 4,000 feet at Cradle Mountain, as evidenced by Lake Wilks, and similarly in the National Park and Mt. Anne, as shown by the elevated tarns at about that height. The duration was only sufficient for very small cirques and rock-scooped basins to be formed. Small hanging or cliff glacierets and horseshoe glaciers grew, but did not travel far or obscure the evidence of the Riss glaciation. One of the best specimens of a moraine the writer has seen, however, lies to the east of Lake Newdigate in the National Park, and is attributable to this period. The distinguishing feature of the Würm glaciation may be said to be the mountain tarn.

A point that warrants passing note here and needs further investigation is the effect of one of these periods of glaciation on the edge of our higher mountains. At about 3,500 feet round the mountains of the centre, south, and north-east of Tasmania run lines of cliffs. The regularity with which these occur suggests that during one of these ice periods, probably the Würm, the nivation layer in the atmosphere rested at this height round the contour of the mountains, and here the intense frost action carved out the lines of cliffs so common near the tops of our mountains, such as the "Organ Pipes" on Mt. Wellington, the Bluffs of Ben Lomond, and the cliffs in which the northern face of the Western Tiers culminates. The concave shape of many high mountain peaks, Mt. Ida and Wyld's Crag for example, may be due to the fact that they protruded their summits into this nivation layer, which has worn a circlet of cliffs round the peak. These cliffs formed the starting point of an ice flow, resembling a collar round the mountain, which descended the slope for some distance before melting. There is ample evidence on Mt. Wellington and on the track to Lake Fenton under Mt. Field East of accumulations of rocks resembling moraines and almost certainly ice borne. At least many of them could not have rolled into their present position, and it is clear that they reached their present position before the present vegetation grew up.

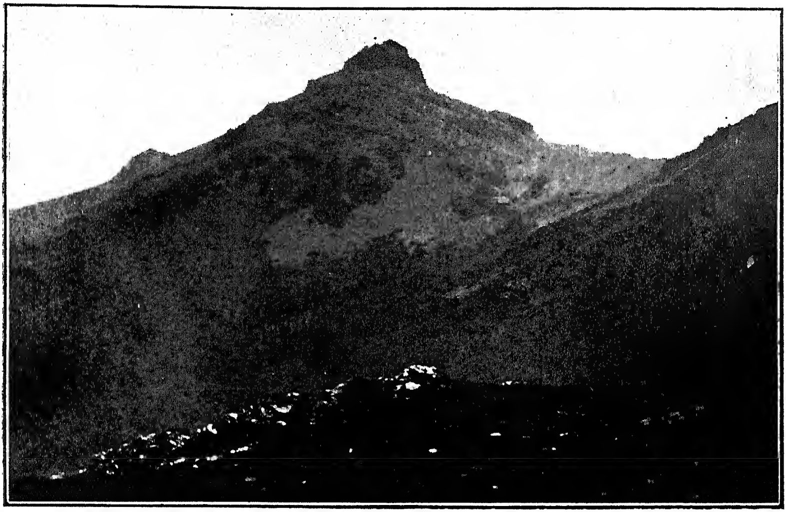


Fig. 7.

THE SUMMIT OF MT. ANNE.

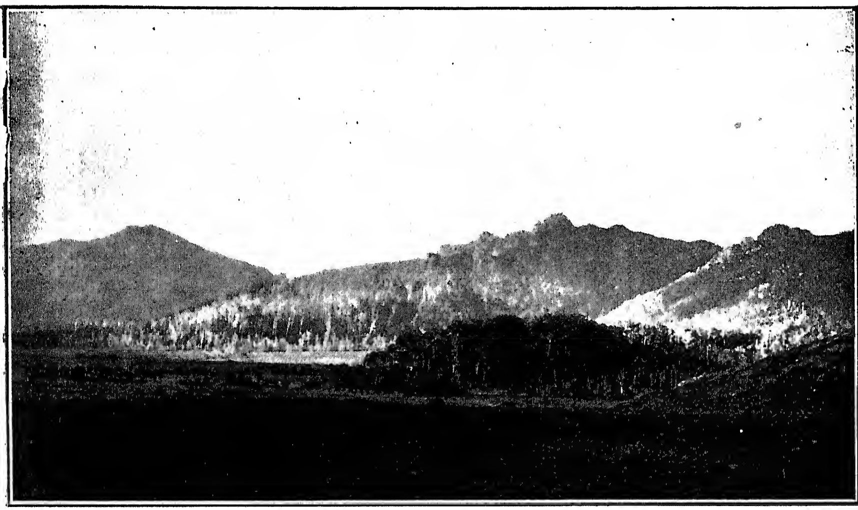


Fig. 8.

THE TERMINAL PEAKS OF THE NORTHERN OF THE TWO WESTERN SPURS OF MT. ANNE. (A. N. Lewis, photo.)

(c) Cycle of Glacial Erosion in Tasmania.

There is one further phase of the study of the Pleistocene glaciation in Tasmania that deserves passing mention. As in the case of water-eroded topography, we have in glacial topography a cycle of erosion corresponding to the length of time during which a locality has been subjected to the effects of ice. Professor Hobbs defines the possible classes as follows:—

(1) The youthful channelled or grooved upland.

(2) The adolescent early fretted upland.

(3) The fretted upland of full maturity.

(4) The monumented upland of old age.

In the case of (1), cirques and glacial valleys merely groove the upland, leaving much of the pre-glacial surface still existing and clearly recognisable. In (2) the cirques have extended until they have met, and are separated by a serrated "Comb" ridge representing all that is left of the original surface. In (3) these lateral combs have disappeared leaving glacial horns (e.g., the Matterhorn) standing at the place where the heads of the cirques of the district junction. In (4) even this has disappeared, and all that is left are pairs of twin peaks, or "monuments," which formed that part of the upland which stood at the entrance to the U valleys, these being the last to be affected by the cirque enlargement, which takes place from the head outwards (Hobbs, 1910, 1921).

In Tasmania most of our glaciated areas have reached a stage bordering on the adolescent, early fretted upland. In most areas there is very little pre-glacial upland left. In the case of the National Park there are stretches of pre-glacial surface a few hundreds of yards across on the Field West and Mt. Mawson ridges and a mile or so on the Field East ridge, where the glaciation has not been so severe, while the Hayes and Newdigate Cirques have eaten into the Rodway ridge until the pre-glacial surface has disappeared, and we see the beginning of the formation of a comb ridge.

On La Pérouse there is a very fine example of a comb ridge. On the Mt. Anne range the process has extended a little farther. The cirques have commenced to cut down the comb ridges between them, and we see rudimentary glacial horns appearing in "Lot's Wife," the cone-shaped pinnacle to the east of Lake Judd, and the summit of Mt. Anne itself. On Cradle Mountain the process has gone still farther until the separating ridges have been quite smoothed out and the

main pinnacles of Cradle Mountain and Barn Bluff stand out 1,000 feet above the surrounding cols. These are glacial horns in the making, but the process is far from complete, and it can hardly be called a type of fully mature glacial topography. Doubtless the extremely hard diabase [illegible] of most of our mountains has hindered the development of the glacial cycle as it is hindering the development of the river cycle, and if we had had mountains of soft sedimentary rocks we would probably have had peaks to rival the Matterhorn, in outline if not in altitude. It is the Riss glaciation that has been responsible for the development of this topography. The Mindel ice sheet had more of a rounding effect and the Würm was of too short a duration to have a great effect, although it has accentuated the degree of erosion at the top of the Riss cirques and in many places has completed the formation of the comb ridge.

5. ECONOMIC POSSIBILITIES OF THE AREA.

(a) Mining.

It is difficult at present to see a great future before the district. As settlement extends the eastern part will be absorbed into the cultivated portion of Tasmania, but, short of the discovery of mineral wealth, it is hard to see what use can be made of the bulk of the area. For many years there have been rumours of the existence of gold under Mt. Anne, and the area has been constantly prospected, chiefly by parties from the Huon, but without appreciable results. The quartzites of the area are potential mineral-bearing rocks, but beyond this there appears little justification for hopes of discovery of a great mineral field here. The tiny patch of serpentine on the Weld is the only trace of an occurrence in the district of an igneous rock with which minerals are usually associated. The veins of quartz that traverse this bed of quartzite of Cambro-Ordovician age lying between Mt. King William and La Pérouse do not appear to be an indication of the presence of minerals.

The locality has been well prospected. The western slopes of Mt. Anne would be easy to examine, and it is reasonable to suppose that they have been well searched. A lode there would be difficult to miss if a prospector investigated the faces of the main spurs. In the Weld Valley, on the other hand, the country is most densely covered with jungle, and cannot have been at all thoroughly investigated, while the presence of a little serpentine is a hopeful sign. If mineral wealth exists here the eastern slopes of Mt. Anne,

the western slopes of the Jubilee, and the gorge of the Weld between seems to be the most likely location. Although little hope in this respect can be held out the area warrants, and would possibly repay, a detailed investigation by the Geological Survey.

Mr. Renison Bell reported the existence of gold somewhere in the area, but exactly where he located it cannot be ascertained. He evidently did not consider the find of much value. On 2nd February, 1897, Henry Judd and Michael Gallagher lodged an application for a reward claim for gold reported to have been found on the north bank of the large western branch of the Weld. Their corner peg blaze is still distinguishable at the end of the old track up the creek, as indicated on the sketch plan attached to this paper. However, the applicants did not pay the fees and the block was never surveyed. The application lapsed, and apparently was not considered of value by the applicants. There is also a corner peg blaze on the old Weld track just above the patch of serpentine, but no application for a lease of this or any other spot in the area has been lodged with the Mines Department.

At the mouth of the Weld a reward claim for nickel and cobalt was awarded to H. E. Evenden in 1920. A little work has been done here and the lease is still effective, but apparently nothing is being done towards extended operations. The minerals here were obtained from the alluvial flat described above, just at its upper border. If the river has cut through any old lodes, minerals may exist in this flat. Some of the small boulders removed from a small shaft on this claim bore close resemblance to flint, and Mr. Gilbert Rigg, of the Electrolytic Zinc Ltd., who was good enough to have some pieces analysed, considered the specimens were true flint. Some specimens were then submitted to the Geological Survey, but the Director reports that although they bear a close resemblance to flint they are only a form of chalcedony. Some deposits of a very pure clay also occur near the mouth of the Weld. On the Styx a claim has been taken up for lithographic stone.

(b) Agricultural.

Agriculturally the area does not appear to have great possibilities. The lower third of the Weld Valley possesses fair soil of a nature and depth common in diabase and mudstone country in Southern Tasmania, and the sandstone higher on the hills indicates that somewhat better soil exists

there. The entrance to the Weld Valley over the river flats and quartzites is unpromising, but there appears to be some ten miles or so of country which is at least no worse than the majority of the Huon district. There is some similar country around Mt. Mueller and doubtless on the flanks of the Snowy Mountains, all of which will warrant opening up as facilities are pushed farther out.

But the quartzite country that composes most of the area is very poor. The hard siliceous rock weathers very slowly, and with the heavy rainfall that exists there steep hillsides are washed bare before soil can accumulate to any depth, and will only support buttongrass and small flowers. Around the head waters of the Styx and Weld soil from this quartzite and the limestone deposits there has accumulated to a considerable depth and now supports a luxuriant forest growth. Much of this land will probably support agricultural crops when its turn comes to be opened up, and the heavy rainfall will assist cultivation, but when the forests are removed it is doubtful whether the shallow soil will not be washed away.

The timber in the Weld Valley appeared poor and patchy although there are good quantities of Beech (*F. cunninghami*). On the south-west of Mt. Mueller there is a fine but small area of Yellow Gum (*E. gunnii*) and mountain peppermint (*E. coccifera*). The lower slopes of Mt. Mueller will yield quantities of valuable timber for the Tyenna mills, and the Weld Valley possesses enough to make it worth while protecting until it can be milled, but it is not a pre-eminent timber area.

The western half of the area is at present valueless. Half has been scraped bare of soil by recent glaciation and the other half strewn with outwash gravels consisting largely of small angular chips of quartzite. The utilisation of the great buttongrass swamps of the west is one of the most pressing problems at present. It would pay the Government handsomely to institute research work into their possibilities and requirements for cultivation, but without systematic scientific research every effort to use them will be wasted, and it would be certainly a leap in the dark to spend money on them in, for example, planting exotic pines, without knowing more about them than we do at present.

Should this area ever be used it is to be hoped that the possibility of canalising the Huon and joining it by a canal via Lake Pedder to the Serpentine and thence to the Gordon will not be overlooked. This should prove quite possible,

and on the surface appears the cheapest way of providing transport facilities to the back country here.

Mt. Anne when opened up will prove one of the foremost scenic areas of our island, and probably its most promising future appears to lie in its being made accessible for ordinary tourists.

APPENDIX (A.)

(Extract from account by H. Judd, 1898.)

Contributed by Major L. F. Giblin.

You pass on up the same river [Weld] until you come under the northern end of the Weld Mountain, which is very high and rugged, and here you hear the sound of a distant waterfall. The next object you see is Mt. Ann, which has a pinnacle of rock, which takes many different forms as you go round the mount, which is 5,020 feet high. Upon the southern side there is a stream of water that flows over a ledge of rock upon the top of the mount into space. So very high is it that it is thrashed into vapour before it can get to the earth, and has the appearance of a floss of silk floating about in the air by the change of wind. In this way the forest is watered by a vapour from it. At the western end of Mt. Ann you enter a small belt of low gum trees, then comes before you one of the most enchanting sights that anyone ever wished to behold.

This mountain has been burst open by some great power in Nature, leaving it with perpendicular walls of over 4,000 feet high upon three sides, and filled up with a beautiful lake called Lake Judd, discovered in 1880. This lake is about one and a half miles long and half a mile broad; perhaps it is larger, as I had no means of measuring it. The beauty here cannot be exaggerated. As you look into the water you at once see all the surrounding beauty of these high walls, with their rugged rocks and lovely spots of all sorts of green and dead reflected in the water below, with the dropping water from the snow above. When I first found this lake I was upon the top of the mountain, and came suddenly upon the edge of the large vault below, which made me tremble with fear, as I was in snow at the time, December. Opposite to this, westerly, is another opening between two mountains, and as you enter it you come to where the sides of the hill are broken back and a miniature lake in the centre. Proceeding further a new sight bursts into view, and you find that the inner part of the high mountain is thrown back on every side, opening out the

bowels of the earth to view, with hundreds of different strata of rock of all sorts and thickness one above the other down to the slate formation. In the centre of this great amphitheatre, with its ledges of rocks to sit upon is a large lake in the centre and a conical-shaped rock of different coloured slate, polished smooth by the fallen rain and storms of passing time. Here you can sit and study geology from Hugh Miller's book of nature, as I call it, with all the quiet that surrounds thought in such places.

APPENDIX (B.).

EXPLANATION OF PLATES AND TEXT FIGURES.

PLATE I.—Sketch of the area described. The scale is approximately 8 miles to the inch. The scale and details must be taken as very approximate.

ERRATA.—In Legend for Ordovician Limestones read Silurian Limestones, and for Cambrian read Cambro-Ordovician.

Text figure is a sketch across the area described from east to west made looking south from the side of Mount Field East.

PLATE II., Fig. 1.—Shows the Mount Anne Range from the west. It is taken from the edge of the Huon Plains looking up the large cirque between the two western outliers, seen on both sides of the picture. The summit of Mt. Anne is at the left (north) end of the range. An easy ascent can be made up the spur seen on the right of the picture.

PLATE II., Fig 2.—Looking north-west at the Anne Range from the foothills of Mt. Weld. "Lot's Wife" is seen on the right of the range, and the summit of Mt. Anne is the next peak to the left. One of the two south-eastern cirques is seen in the centre of the picture. The valley in the foreground is that of the western branch of the Weld. Judd's Reward Claim is in the valley at the extreme right of the picture. This photo was taken from the farthest point reached by the party in 1921.

PLATE III.—Sketch plan of Mt. Anne showing the location of the more important features. The relative positions of the south-eastern features are very approximate.

PLATE IV., Fig. 3.—Looking south from the south end of the Mt. Anne Plateau. Smith's Tarn can be seen in the centre of the opposite ridge. The south-east end of the Arthur Range is in the background.

PLATE IV., Fig. 4.—The Huon Plains looking west from the southern of the two western spurs of Mt. Anne. The Huon runs in the line of scrub in the far distance. Lake Pedder lies at the back of the prominent hill on the right centre. The ranges in the background are the southern terminals of the Frankland Range. The mountain in the background on the left is Mt. Giblin.

PLATE V., Fig. 5.—Looking east from near the summit of Mt. Anne down the large cirque on the east of the summit. "Lot's Wife" is in the centre, and the Snowy Mountains in the background, with the Weld Valley in between.

PLATE V., Fig. 6.—The south-western end of Lake Judd taken from the Mt. Anne Plateau. Mt. Picton is in the distance in the centre, and Precipitous Bluff is the conical mountain to its left.

PLATE VI., Fig. 7.—The top of Mt. Anne looking across the western cirque from the top of the second spur, the quartzite of which can be seen in the foreground. The light patches on Mt. Anne are slopes of Diabase talus.

PLATE VI., Fig. 8.—The terminal peaks of the northern of the two western spurs of Mt. Anne. Cirques separate these peaks, which are glacial monuments in an early stage of development.

(Photos by the writer.)

APPENDIX (C.).

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Ward, L. Keith. 1909.—Systematic Geology. The Pre-Cambrian. P. and P. Royal Society of Tasmania, 1909.

VINCULUM SEXFASCIATUM, RICHARDSON.

AN ADDITION TO THE FISH FAUNA OF TASMANIA.

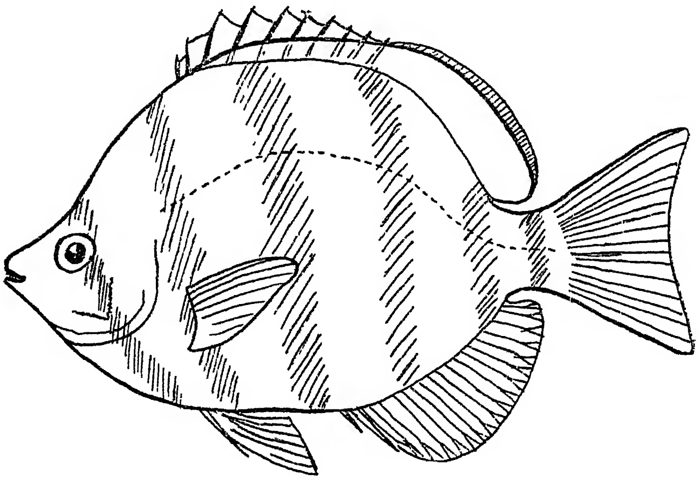
By Clive Lord, F.L.S.
Director of the Tasmanian Museum.

(Read 9th July, 1923.)

The following species has been recorded from Western Australia and Victoria. It has also been reported from New South Wales, but McCulloch (1922, p. 65) queries the reliability of this record. The species has not previously been recorded from Tasmanian waters.

FAMILY *CHÆTODONTIDÆ*.

Vinculum sexfasciatum, Richardson.
Six-banded Coral Fish.



Vinculum Sexfasciatum Richardson X¼

Chætodon sexfasciatus.

Richardson, A.M.N.H. (1842), p. 26.
Gunther, B.M. Cat. Fish (1860), p. 35.
Castelnau, P.L.S. N.S.W. (1879), p. 350.
Macleay, P.L.S. N.S.W. (1881), p. 388.
Kershaw, Vict. Nat. (1911), XXVIII., p. 94.

Vinculum sexfasciatum.

McCulloch, Endeavour Scientific Results (1914), II., 3, p. 110.

McCulloch, Aust. Zoologist, II., 3, p. 91.

Waite, Fishes of S.A., Rec. S.A. Museum, II., 1, p. 115.

The genus *Vinculum* was proposed by McCulloch (1914, p. 110). It differs from *Chætodon* in having very much smaller scales and fewer dorsal spines. The latter being limited to ten.

The specimen recently presented to the Tasmanian Museum was secured on the East Coast of Tasmania by Messrs. Dale and Davis. It is the first of the *Chætodontidæ* to be recorded from Tasmanian waters. The specimen measured 375 mm. (over-all measurement when fresh), and its occurrence on our coasts is of interest.

Tasmanian Museum Catalogue, No. D. 730.

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1914 McCulloch, Endeavour Scientific Results, Vol. II., pt. 3, p. 110.

1922 McCulloch, Fishes of New South Wales, Aust. Zoo Handbook, No. 1, p. 65.

A NOTE ON THE BURIAL CUSTOMS OF THE TASMANIAN ABORIGINES.

By Clive Lord, F.L.S.,
Director of the Tasmanian Museum.

(Read 9th July, 1923.)

The methods of burial as practised by primitive races are of distinct interest in assisting to trace their evolutionary history. Owing to the lack of authentic information in detail of the customs of the Tasmanian aborigines, our knowledge is, in many matters, vague and uncertain. Often the observations relating to the aborigines were made years after their contact with the white race, and naturally their customs had been affected.

Further, the more one studies the early records and observations made by early colonists, the more one realises their contradictory nature. The available evidence which could be gathered from early records has been admirably summarised by Ling Roth (1899, pp. 116-122). A later paper by Noetling (1908, p. 36) dealt with the supposed native burial ground near Ross, but, personally, I am unable to agree with all the conclusions arrived at by Dr. Noetling. In a later paper Noetling (1910, p. 271) again referred to the matter, but his deductions are at variance with the observations of the French naturalist Péron, who distinctly states that the tombs found by the French on Maria Island in 1802 were placed near the camping ground.*

There is sufficient evidence to show that the natives usually burnt their dead, and often, after cremating the body, the residue would be buried or certain portions carried as a charm. In some cases the body would not be burnt, but would be placed in a hollow tree or a shallow grave.

I am not aware of any authentic records as to the position of the buried body, and hope that the following observation, made in exhuming aboriginal remains, may be of interest, as information on the point helps to illustrate the evolutionary status of the race.

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*It must be remembered of course that in regard to the tombs referred to by Peron the bodies had first of all been cremated and the remains gathered and placed in the ground, over which a frail superstructure of grass and bark had been raised.

In January, 1919, a number of Tasmanian aboriginal remains were found at Eaglehawk Neck, as already recorded in the Papers and Proceedings of the Royal Society of Tasmania (1918, pp. 118-119; 1920, pp. 140-152). In exhuming these remains I particularly noticed that the bodies were doubled up in most cases, the skull being closely wedged between the femurs. Owing to doubts as to how the skeletons came to be there and also owing to the fact that the sand dune in which the excavations were made showed signs of movement, it was not thought fit to make any comment at that time. Recently, however, a further discovery was made in the sand dunes at the south end of Ralph's Bay, where Mr. E. A. Calvert found portion of an aboriginal skeleton. This he kindly presented to the Tasmanian Museum. I subsequently visited the site of the discovery in company with Mr. Calvert, and, in questioning him as to the exact position of the bones, I found that, according to his description, they were placed in practically the same position as the ones which had been found at Eaglehawk Neck.

Judging from observations made in the above mentioned cases there is some evidence to show that such bodies as were buried were placed in the thrice bent sitting position. Further evidence is needed, however, before it is safe to assume that the above position is typical, and the present note is written merely in the hope that it may be of assistance in the event of further discoveries being made.

LITERATURE REFERRED TO.

1899 Roth, H. Ling, Aborigines of Tasmania.

1908 Noetling, Papers and Proceedings Royal Society of Tasmania, 1908.

1910 Noetling, Papers and Proceedings Royal Society of Tasmania, 1910.

MOLLUSCA OF KING ISLAND.

By W. L. May.

WITH DESCRIPTIONS OF FIVE NEW SPECIES.

Plate VII.

(Read 9th July, 1923.)

During the month of November, 1922, I spent some days on King Island visiting relatives, and took what opportunity offered to investigate the Mollusca. No really comprehensive list of the Island's shell fauna appears to have been published. In one of the early French expeditions in 1802 the Naturalists Péron and Lesueur made considerable collections, their take being worked up principally by Lamarck and Blainville. Some of the species described by Tenison-Woods in the seventies of last century were from the Island, and they and others appeared in his Census which was compiled in 1877. Some of these, however, have not been retaken and require confirmation. The late Professor Tate had a small parcel of King Island shells sent him by some correspondent, and they were recorded by Tate and May in their Revised Census, 1901. There also appeared in the Victorian nature publication, "The Wombat," Vol. V., page 35, 1902, a fairly long list containing 135 species.

I collected at Currie Harbour, Surprise Bay, Fraser, and near "Grassy." The first two on the West Coast, and the others on the East.

The most remarkable feature was the absence of many common Tasmanian shells, particularly the larger bivalves. I saw no sign of our common edible mussel, *M. planulatus*, no *Dosinia* or *Mactra*, scarcely any *Pectens*, neither *Tellina*, *Gari*, nor *Cardium* appeared, and the *Veneridiæ* were only represented by *Antigona lagopus* and *Gomphina undulosa*. I saw no Trigonias, but was assured that they have been taken near Fraser. The Chitons are moderately represented, *Heterozona subviridis* being extremely abundant, but *Sypharochiton pellis-serpentis*, so common all round the Tasmanian coast, was not seen. The West Coast is very rough and wild, and quite exposed to the prevalent westerly gales; here the rock fauna were Limpets, *Monodonta*, *Bembicium*,

and a few Chitons, with a goodly number of minute forms, found in shell sand, such as generally live under and amongst stones and rocks. A much more sheltered spot is Fraser on Sea Elephant Bay, Middle East Coast, and here washed up on the beach were most of the larger species taken. A longer residence at this spot would doubtless add considerably to the list. Two species of land shells were taken, and the larger one, *Chloritis victoriæ*, is very interesting, as its appearance seems to suggest the necessity of land communication with Victoria at some period, as this species occurs in that State, but not in Tasmania. The great majority of the marine species are also common to Tasmania, although a few Victorian species appear which have not yet crossed to Tasmania. An extremely small percentage appear peculiar to the Island; one of them is *Cantharus kingicola,* Tate and May, and there are four minute species which appear to be new to science, and which I take this opportunity to describe. In the following list there are some species not taken by myself; those of them which appear in the "Wombat" list are marked by an *, and those from Tenison-Woods' descriptions and Census by a †. Altogether I here catalogue 227 species.

Philobrya subpurpurea, Sp. nov.

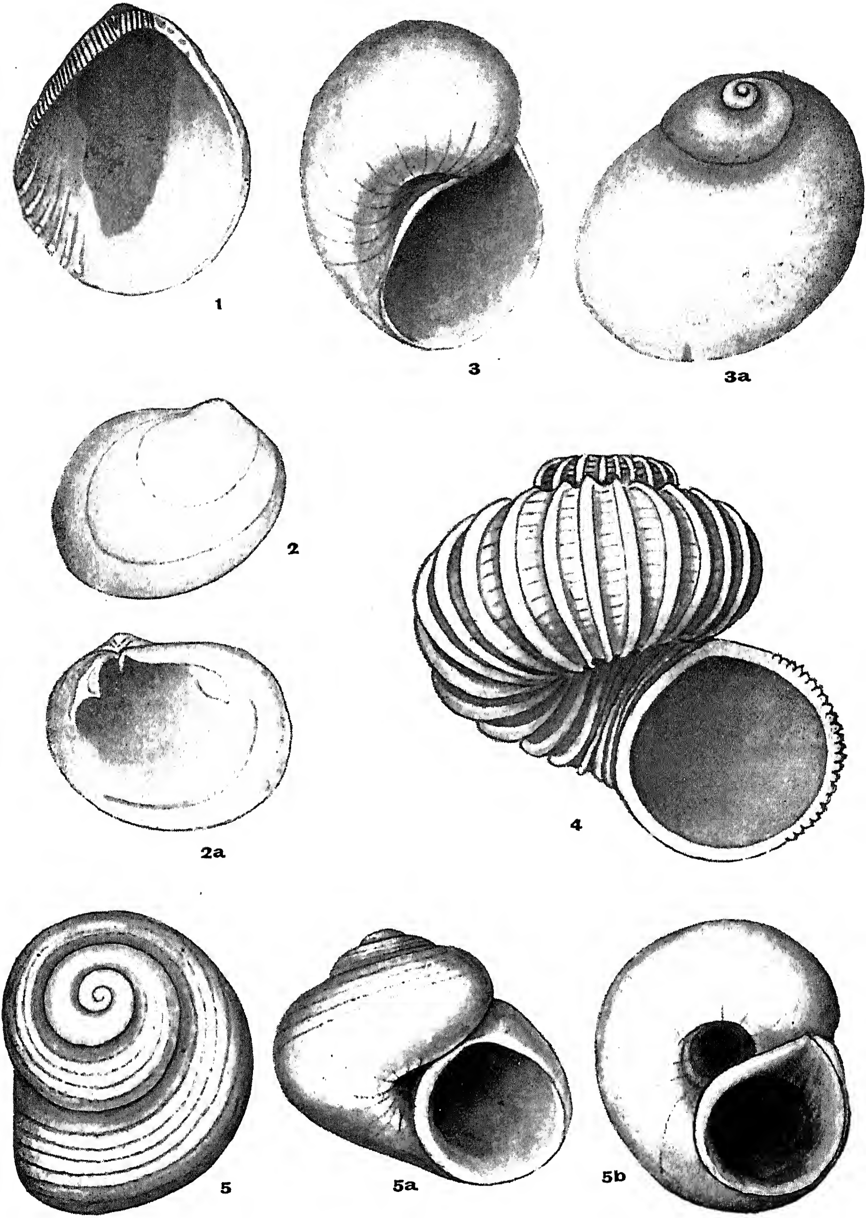
Shell minute, ovately pyriform, hinge line straightish. Proto-conch small and inconspicuous, consisting of a minute boss on a small flattened area. Colour yellowish, purplish brown at the umbos, extending downwards over part of the shell. Dead shells are white, with a purple stain branching from the umbo on each side of the centre of the valve. The exterior is smooth except for rather prominent growth lines. The hinge consists of a series of vertical ridges and grooves on a flattened plate, and below this are about six ridges or liræ which slightly crenulate the margin on what I take to be the posterior side.

Dimensions of Type.—Height, 2; breadth, 1.7 mill., but some specimens are rather larger. Pl. VII., fig. 1.

Type from Fraser, King Island, taken by Mr. Basset-Hull. I also collected numerous single valves in shell sand at Currie Harbour.

Mylitta polita, Sp. nov.

Shell minute, smooth, glossy, shining, and semi-transparent, very inequilateral, much produced on the anterior side, umbos small. Internally there is a strong flattened



1. *Philobrya subpurpurea.*
2, 2a. *Mylitta polita.*
3, 3a. *Natica kingensis.*
4. *Brookula consobrina.*
5, 5a, 5b. *Argalista kingicola.*

posterior tooth, and a minute prong-like tooth immediately beneath the umbo.

Height, 2; width, 2.4 mill. Pl. VII., figs. 2, 2a.

Hab.—Surprise Bay, King Island, in shell sand, six single valves.

In size, and to some extent outline, this resembles *M. gemmata*, Tate, from South Australia, but that species is ornamented with divaricating sculpture, and is still more inequilateral. Shells of this genus are usually strongly sculptured; the present species is therefore remarkable for its perfect smoothness.

Natica kingensis, Sp. nov.

Shell very small, ovately turbinate with a small spire, perforate. Colour light yellowish chestnut, a darker band immediately below the suture, and a broader light band below that; there is a patch of deeper colour behind the umbilicus, which is rather small, narrow, and deep. Whorls four, rapidly increasing, the body whorl large. Aperture semi-lunar, sharply pointed above.

Height, 2.5; diameter, 2 mill. Pl. VII., figs 3, 3a.

Hab.—Plentiful in shell sand at Currie Harbour, King Island, where about 200 specimens were collected, which are of very uniform size.

I place this little shell in *Natica*, as its general characteristics seem to point to that genus, but this may not be its final location.

Argalista kingensis, Sp. nov.

Shell small turbinate, solid, dull white, with faint brown rays, perforate. Whorls four, rapidly increasing; spire not much elevated. The upper surface is faintly spirally lirate; under surface smooth. Aperture roundly pyriform, the columella lip somewhat expanded, behind which is an ample umbilicus.

Major diameter, 2.5; height, 1.8 mill. Pl. VII., figs. 5, 5a, 5b.

Hab.—Type with three others from Surprise Bay, King Island, in shell sand. All the specimens are rather beach worn.

This is close to *A. fluctuata*, Hutton, from New Zealand, which differs principally in its smaller umbilicus and

stronger sculpture, which persists on the base. Better preserved examples may prove the King Island shell to be a variant of the New Zealand species.

Brookula consobrina, Sp. nov.

Shell minute, globosely turbinate, perforate, solid, dirty-white, rather corroded. Whorls four, first one and a half unsculptured and scarcely raised above the succeeding whorls, which are crossed by strong axial ribs widely separated and laminate, about 30 on the first turn of the body whorl, the interstices crossed with fine regular liræ which are scarcely discernible on most specimens Aperture almost round continuous, outer edge finely notched by the revolving liræ. Umbilicus medium sized and deep.

Diameter, 1.5; height, 1.3; Pl. VII., fig. 4.

Type with 18 others from 40 fathoms off Thouin Bay, Tasmania.

This species is a very typical *Brookula*, and scarcely differs from the type of the genus *B. stibarochila*, Iredale, from the Kermadecs. Pro. Mal. Soc. X., pt. iii., 1912, p. 220. Our shell appears rather higher and has a smaller mouth. It is also very close to *B. densilaminatum*, Verco, which shell has a more elevated pullus, and ribs about twice as numerous. Intermediate forms may yet be found.

LIST OF KING ISLAND MOLLUSCA.

Pronucula micans, Angas.
Lissarca rhomboidalis, Verco.
Arca metella, Hedley.
Glycymeris flabellatus, Ten.-Woods.
**Philobrya fimbriata*, Tate.
Philobrya subpurpurea, May
Notomytilus ruber, Hedley.
Ostrea Spe?
Neotrigonia margaritacea, Lamk.
Pecten medius, Lamk.
Chlamys asperrimus, Lamk.
Lima strangei, Sowerby.
Brachyodontis rostratus, Dunker.
Modiolus australis, Gray.
Myochama anomioides, Stutchbury.
Venericardia amabilis, Deshayes.
Venericardia exulata, Smith.

Cardita calyculata, L.
Condylocardia crassicosta, Bernard.
†*Codakia bella*, Conrad.
**Codakia lacteola*, Tate.
**Codakia minima*, Ten.-Woods.
**Lucinida assimilis*, Angas.
**Diplodonta zelandica*, Gray.
**Neolepton rostellata*, Tate.
Rochefortia donaciformis, Angas.
Lasæa australis, Lamk.
Lasæa miliaris, Phil.
**Mylitta auriculata*, Smith.
**Mylitta deshayesi*, D'Orb.
Mylitta polita, May.
**Mylitta tasmanica*, Ten.-Woods.
Macrocallista diemenensis, Hanley.
Antigona lagopus, Lamarck.
Gomphina undulosa, Lamk.
Venerupis exotica, Lamk.
Solen vaginoides, Lamk.
**Spirula spirula*, L.
Sepia apama, Gray.
Sepia cultrata, Hoyle.
Ischnochiton atkinsoni, Iredale and May.
Isch. iredalei, *Dupuis* Var.
Isch. lineolatus, Blainville.
Isch. smaragdinus, Angas.
Isch. evanidus, Sowerby.
Isch. subviridus, Iredale and May.
Isch. virgatus, Reeve.
Callistochiton meridionalis, Ashby.
Plaxiphora albida, Blainville.
Plaxiphora tasmanica, Thiele.
Acantho. costatus, Ad. and Ang.
Acantho. sueurii, Blainville.
Acantho. variabilis, Ad. and Ang.
Acantho. kimberi, Torr.
Cryptoplax striatus, Lamk.
Scissurella rosea, Hedley.
Schismope atkinsoni, Ten.-Woods.
Schismope beddomei, Petterd.
Scutus antipodes, Montfort.
Hemitoma aspera, Gould.
**Emarginula bajula*, Hedley.
**Emarginula candida*, Adams.
**Lucapinella nigrita*, Sowerby.

Puncturella harrissoni, Beddome.
Haliotis albicans, Quoy and Gaim.
Haliotis emmæ, Reeve.
Haliotis nævosum, Martyn.
Stomatella imbricata, Lamk.
Gena strigosa, Adams.
Clanculus flagellatus, Phil.
Clanculus limbatus, Quoy and Gaim.
Clanculus maugeri, Wood.
Clanculus plebejus, Phil.
Clanculus yatesi, Crosse, var. *Aloysii*, Ten.-Woods.
Cantharidus eximius, Perry.
**Cantharidus irisodontes*, Quoy and Gaim.
Monodonta adelaidæ, Phil.
Monodonta concamerata, Wood.
Monodonta constricta, Lamk.
Monodonta odontis, Wood.
Cantharidella tiberiana, Crosse.
Calliotrochus legrandi, Petterd.
Fossarina petterdi, Crosse.
**Calliostoma hedleyi*, Prit. and Gat.
Calliostoma meyeri, Phil.
Euchellus baccatus, Meuke.
Euchellus scabriusculus, Ad. and Ang.
Phasianella australis, Gmelin.
Phasianella perdix, Wood.
Phasianella rosea, Angas.
Turbo gruneri, Phil.
Turbo undulatus, Martyn.
Astræa aurea, Jonas.
Astræa fimbriata, Lamk.
Cirsonella weldii, Ten.-Woods.
Zalapais inscripta, Tate.
Microdiscula charopa, Tate.
Lodderia minima, Ten.-Woods.
Liotina subquadrata, Ten.-Woods.
Argalista kingensis, May.
Nerita melanotragus, Smith.
Patelloida alticostata, Angas.
**Patelloida conoidea*, Quoy and Gaim.
Patelloidea inradiata, Reeve.
Patelloidea marmorata, Ten.-Woods.
Patelloida scabrilirata, Angas.
Patella ustulata, Reeve.
Cellana limbata, Phil.
Melarhaphe prætermissa, May.

Melarhaphe unifasciata, Gray.
Bembicium melanostoma, Gmelin.
Risellopsis mutabilis, May.
Haurakia strangei, Brazier.
Haurakia supracostata, May.
Lironoba tenisoni, Tate.
Lironoba unilirata, Ten.-Woods.
Merelina cheilostoma, Ten.-Woods.
Merelina hulliana, Tate.
Dardanula melanochroma, Tate.
Estea approxima, Petterd.
Estea incidata, Frauenfeld.
Anabathron contabulatum, Frauenfeld.
Rissoina fasciata, Adams.
†*Rissoina gertrudis*, Ten.-Woods.
Rissolina angasi, Pease.
**Diala semistriata*.
Diala lauta, Adams.
Potamopyrgus nigra, Quoy and Gaim.
†*Acmea scalarina*, Cox.
Hipponix conicus, Schumacher
Hipponix foliacea, Quoy and Gaim.
Plesiotrochus monachus, Crosse and Fischer.
**Ataxocerithium serotinum*, Adams.
Pyrazus demenensis, Quoy and Gaim.
**Bittium granarium*, Kiener.
Cerithiopsis turbonilloides, Ten.-Woods.
Seila albosutura, Ten.-Woods.
Triphora tasmanica, Ten.-Woods.
**Epitonium aculeatum*, Sowerby.
Epitonium australe, Lamarck.
**Epitonium granosum*, Quoy and Gaim.
Epitonium jukesianum, Forbes.
Cymatium speugleri, Perry.
Eugyrina subdistorta, Lamarck.
Personella eburnea, Reeve.
Personella verrucosa, Reeve.
**Phalium semigranosum*, Lamarck.
Natica kingensis, May.
Sinum umbilicatum, Quoy and Gaim.
Cypræa angustata, Gmelin.
Trivia australis, Lamarck.
Scaphella undulata, Lamarck.
Ancilla marginata, Lamarck.
**Ancilla petterdi*, Crosse.
Marginella albida, Tate.

Marginella angasi, Crosse.
Marginella formicula, Lamarck.
Marginella subbulbosa, Tate.
**Marginella ovulum*, Sowerby.
†*Cancellaria purpuriformis*, Kuster.
Cancellaria spirata, Lamarck.
**Cancellaria undulata*, Sowerby.
Terebra albida, Gray.
Duplicaria ustulata, Deshayes.
Conus anemone, Lamarck.
**Conus rutilus*, Meuke.
Apaturris alba, Petterd.
**Guraleus mitralis*, Adams and Angas.
Guraleus pictus, Adams and Angas.
Austrodrillia beraudiana, Crosse.
†*Inquisitor immaculata*, Ten.-Woods.
**Eucithara compta*, Adams and Angas.
**Etrema bicolor*, Angas.
Nepotilla tasmanica, Ten.-Woods.
Asperdaphne deuseplicata, Dunker.
Fasciolaria australasia, Perry.
Latirofusus spiceri, Ten.-Woods.
†*Verconella dunkeri*, Jonas.
Verconella pyrulata, Reeve.
**Verconella tasmaniensis*, Adams and Angas.
Mitra australis, Swainson.
**Mitra analogica*, Reeve.
Mitra glabra, Swainson.
†*Mitra legrandi*, Ten.-Woods.
Mitra pica, Reeve.
**Mitra tasmanica*, Ten.-Woods.
Cominella eburnea, Reeve.
Cominella kingicola, Tate and May.
Cominella lineolata, Lamarck.
Euthria clarkei, Ten.-Woods.
**Fusus bednalli*, Brazier.
Fusus mestayeræ, Iredale.
Nassarius pauperus, Gould.
**Pyrene acuminata*, Meuke.
**Pyrene leucostoma*, Gaskoin.
Pyrene pulla, Gaskoin.
Pyrene semiconvexa, Lamarck.
Zafra fulgida, Reeve.
Zafra legrandi, Ten.-Woods.
**Murex angasi*, Crosse.
Murex triformis, Reeve.

Murex umbilicatus, Ten.-Woods.
Trophon goldsteini, Ten.-Woods.
**Trophon petterdi*, Crosse.
Thais baileyana, Ten.-Woods.
Thais succincta, Martyn.
**Lepsiella adelaidæ*, Adams and Angas.
Lepsiella reticulata, Blainville.
Lepsiella vinosa, Lamarck.
Marinula parva, Swainson.
Marinula xanthostoma, Adams.
Leuconopsis pellucidus, Cooper.
Siphonaria diemenensis, Quoy and Gaim.
Succinea australis, Ferrusoac.
Chloritis victoriæ, Cox.
Rhytida ruga, Cox.
**Odostomia metcalfei*, Prit. and Gat.
Odostomia portseaensis, Gat. and Gab.
**Turbonilla hofmani*, Angas.
Turbonilla mariæ, Ten.-Woods.
Eulima augur, Angas.
Eulima tenisoni, Tryon.
Melanella petterdi, Beddome.
Pseudorissoina tasmanica, Ten.-Woods.
Retusa apicina, Gould.
Haminœa tenera, Adams.
Philine angasi, Crosse and Fischer.

STUDIES IN TASMANIAN MAMMALS, LIVING AND EXTINCT.

Number XI.

By

H. H. SCOTT, Curator of the Launceston Museum,

and

CLIVE LORD, F.L.S., Director of the Tasmanian Museum.

NOTES ON A MUTILATED FEMUR OF *NOTOTHERIUM*.

(Read 6th August, 1923.)

Among some recently acquired fragments of *Nototherium* bones presented to the Tasmanian Museum by Mr. Burnley, of Mella, near Smithton, and therefore in the locality of the Mowbray Swamp, is the shaft of a femur, obviously that of a Nototherian calf. The bone lacks the head and major trochanter at its proximal end, and distally both the condyles are missing, yet in spite of the several mutilations, the specimen is of especial interest.

It is the thigh bone of an animal that has apparently been hunted, and gripped by a carnivorous animal. Both edges of the bone have suffered, thus suggesting a double attempt at dragging the creature down, one of which was made upon the outer side and a second from between the legs. Two foes falling at a time upon a calf would equally well account for the facts, and if the Carnivores of Pleistocene Australia hunted in packs, this latter is the more likely of the two possibilities.

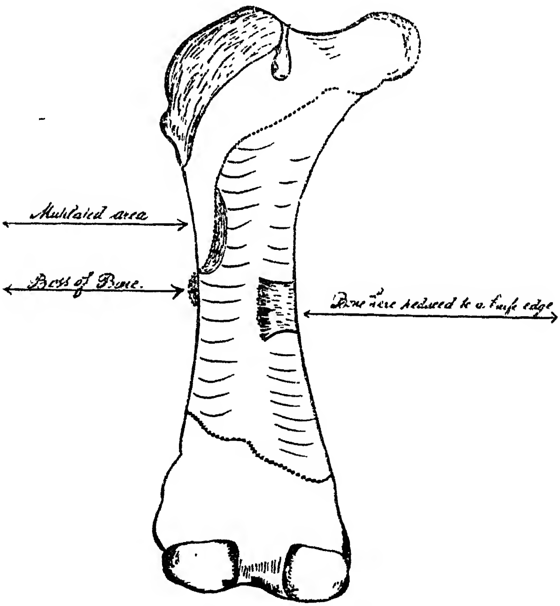
As a second femoral shaft of similar size, and apparently the associate of the mutilated bone, is also present, a very exact comparison of the two is open to us. The wounded animal having escaped its foes, carried to the day of its death the marks of the encounter, in the shape of two contracted bony areas, in which absorption in one instance has reduced one edge to 1 mm. in thickness from a normal of 30 mm.

Externally, the shaft has undergone a series of alterations, resulting in the formation of a groove about 100 mm long, with a thickened boundary edge that in one case at least formed a long boss that has extended beyond the normal outline of the diaphysis.

The diaphysis itself, upon all its faces, has been thrown into a series of transverse hollows and ridges—suggesting a contraction of the periosteal membrane and a later bony secretion that followed the contour of the several corrugations.

The whole character of the double wound upon the inner and outer edges of this Nototherian femur leads to the conviction that a carnivorous animal had at one time attempted the life of its owner. A strong kick would not have produced such results, whilst the imprisonment of the leg in a cleft among rocks or an accidental slip into a hole would have affected more directly the themal and anconal aspects of the shaft.

We are of the opinion that the mutilations were caused by one of the larger marsupial Carnivores, and look to the future for obtaining material proofs of the former existence of *Thylacoleo* and associated animals in the Pleistocene formations of Tasmania.



Text fig.—Approximately one quarter of natural size.

AUSTRALIAN *DIXIDÆ*. [Dipt.]

By A. L. TONNOIR,
Research Student in *Diptera* at the Cawthron Institute, Nelson, N.Z.

(Communicated by Clive Lord.)

(Read 6th August, 1923.)

INTRODUCTION.

Previously nothing was known of the representatives of this family in Australia except a record of Skuse (1) saying that he knew three species belonging to the genus *Dixa* in New South Wales; they remained, however, undescribed, and I have been unable to find the specimens in his collection, preserved *pro parte* in the Australian Museum in Sydney and *pro parte* in the Macleay Museum in Sydney University.

During a short stay in New South Wales and Victoria and one summer spent in Tasmania, I found five species of *Dixa*, and recently Mr. A. J. Nicholson discovered another in New South Wales, which he kindly gave me for study, for which loan I am much obliged to him.

These Australian species indubitably belong to the genus *Dixa*, as they differ very little from the forms of the rest of the world; like them, they are differentiated from each other by mere details of colouration, relative length of antennæ, peculiarities of venation such as the position of *r-m* and relative length of fork of R_{2+3}, and chiefly by the structure of the hypopygium.

Their larvæ, of which three types have been secured, differ also very little from the European forms. Like them, some have the peculiar crown of hair on the dorsum of the abdominal segments 2-7, and some present this dorsum completely smooth; they are provided also with the pair of pseudopods on the two first abdominal segments, the armature of hooks on the 6-8 segment; the mouth-parts and spiracular armature present only minute differential characters in their structures.

(1). Austral. Ass. Adv. Sci., Melbourne, Vol. II., 1890, p. 530.

ADULTS.

TABLE FOR MALE AND FEMALES.

1. Antennæ long, nearly as long as the body, or at least, as the abdomen; basal joints of flagellum elongated and scarcely distinct from each other; *r-m* placed well before fRs. 3.

Antennæ rather short, about as long as thorax; the basal joints of the flagellum somewhat fusiform, well distinct from each other; *r-m* placed at or after fRs. 2.

2. Mesonotum nearly all orange; front legs rather dark; stem of R_{2+3} much longer than R_2; smaller species. *D. FLAVICOLLIS*, n.sp.

Mesonotum with three well-marked dark bands; all legs yellow with dark tip at femora and tibiæ; stem of R_{2+3} somewhat shorter than R_2; larger species. *D. GENICULATA*, n.sp.

3. No other marking on the wing but a spot on *r-m* which extends along the stem of Rs up to R_1; mesonotum orange with two dark bands connected in front. *D. TASMANIENSIS*, n.sp.

Wing spot never extending up to R1; or else wing nebulous and colouration of mesonotum nearly all black. 4.

4. Besides the roundish spot around *r-m* the wings are infuscated on some other parts, chiefly on the apical region; nearly completely dark species. *D. HUMERALIS*, n.sp.

Wing presenting only one spot near *r-m* or scarcely any trace of one. 5.

5. The spot of the wing distinctly marked, rather large, extending on the whole length of the stem of Rs. *D. UNIMACULATA*, n.sp.

The spot of the wing very faint, restricted only alongside *r-m* *D. NICHOLSONI*, n.sp.

DIXA FLAVICOLLIS, n.sp.

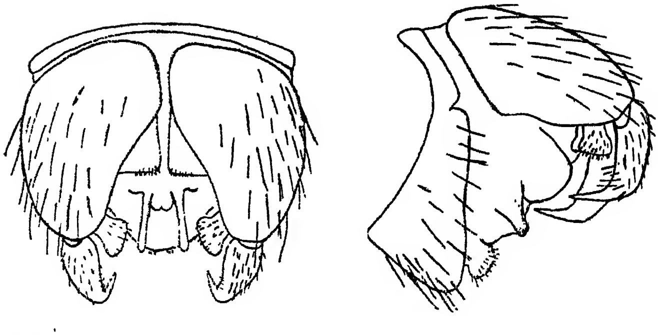


Fig. 1. Hypopygium of *D. flavicollis* from above and from the side.

Male: Face and snout dark yellowish; palpi black; antennæ with scape brown, flagellum black; vertex black, shining. Thorax rather dull orange, with exception of the prothorax blackish; on the middle of the mesonotum, anteriorly, there is the beginning of a dark band, another dark band on the pleuræ between the front and the hind coxæ; a brownish space below the wing's base; coxæ yellow, also the base of femora, which are gradually darker towards their extremity, the hind ones lighter; tibiæ and tarsi brown; apical swelling of hind tibiæ very conspicuous, claws large; halteres with orange stem and light brown knob. Abdomen brownish black, little shining; hypopygium large, completely black; wing nearly hyaline with a small infuscated spot on *r-m*.

Antennæ short, somewhat less than the head and thorax together, with very distinct joints in the flagellum, the basal ones being rather short and fusiform. The palpi with a short first joint, the second and third subequal, about four times as long as wide, last joint about twice the length of the third.

Venation: Origin of Rs well after the tip of Sc; *r-m* before fRs; first part of the stem of Rs three times larger than the second part; stem of R_{2+3} distinctly larger than R_3.

Hypopygium small, the lamellæ showing between the base of the side pieces presenting rounded angle; apical internal process of the side pieces axe-shaped, rather short and hairy on their whole surface; claspers shorter than the side pieces, subcylindrical at base, and then suddenly curved downwards and tapering into an acicular extremity; ædœagus little developed, without any conspicuous hook or process.

Length of wing: 3 mm.

Female: Similar to male in colour, but the median band of the mesonotum more marked, and with two lateral very faintly marked dark bands; otherwise agreeing completely with the type as to colouration and wing venation.

Type and allotype, which were the only specimens captured, come from Sassafras, Victoria, 19th October, 1922. They are in the collection of the Cawthron Institute.

DIXA GENICULATA, n.sp.

Fig. 2. Hypopygium of *D. geniculata* from above and from the side.

Similar to the preceding species but larger, and with darker marks on body but with lighter legs.

Male: Face and snout orange-yellow as well as the scape of antennæ; the flagellum black; palpi also black, vertex brown shining; mesonotum orange with three disconnected brown bands, the median one much abbreviated behind, the lateral ones in front; scutellum orange; post-scutellum infuscated; halteres with orange stem and black knob. Prothorax brown, somewhat dark marks on the pleuræ from the front coxæ to the base of the abdomen and on the lower part of the mesosternum. Abdomen blackish brown, rather dull; coxæ, femora, and tibiæ yellow, the femora with black tip, the tibiæ with slightly darker base and black tip, tarsi brown, the metatarsi somewhat lighter towards their base on the anterior legs, the hind metatarsi distinctly lighter with dark base and extremity. Wing hyaline or scarcely greyish, with Sc and R1 as well as the costal field yellowish, one dark subcircular spot round *r-m* extending downwards on *m-cu*.

Antennæ short, about the length of the thorax, the basal flagellum joints very distinct from each other; palpi as in preceding species.

Venation: Origin of Rs after tip of Sc; first part of stem of Rs double the length of the second part, therefore *r-m* well before fRs; stem of R_{2+3} somewhat shorter than R_2. Hypopygium built on the same plan as in *D. flavicollis*, but the parts differ as follows:—The lamellæ, visible from above between the base of the side pieces, are produced in a small blunt digitation; the internal distal processes of the side pieces are rather long, about half the length of the claspers, and much widened at their extremity, which carries a row of small setæ; the claspers are about as long as the side pieces and nearly straight, their tip, which is suddenly pointed, is somewhat turned down; no conspicuous process or hooks on the ædœagus or the tergum of the hypopygium; as a whole, all the parts are relatively more developed and robust than in *flavicollis*.

Length of wing: 3 2-3 mm.

Female: Similar to the male, the legs very slightly darker, especially the front ones.

Type and allotype from Burnie (Tasmania), 26th, 27th October, 1922. In the collection of the Cawthron Institute. Four paratypes, one male and three females from the same locality, and one female from St. Patrick's River, 21st October, 1922.

This last-mentioned specimen from St. Patrick's River has the dark marking of the mesonotum much obliterated; it corresponds very well in every other point. One female from Sassafras, captured at the same spot as *D. flavicollis*, agrees very well with the characters of *geniculata*, with the size, the wing venation and marking, and the yellow scape, but differs from it in the completely orange mesonotum and halteres as well as by the darker legs. I was, therefore, at first disposed to consider the Tasmanian form as a variety of the Victorian one, but closer examination showed that the points of difference are well marked and justified considering them as different species.

This difference in characters may be summed up as follows:—

Size larger in *geniculata*.

Scape distinctly orange and not brown.

Mesonotal dark bands well marked, and in mesonotum nearly completely orange.

Knob of halteres distinctly black and relatively short.

All femora and tibiæ yellow with dark tip.

Anterior veins yellow.

Spot of the wing extending alongside *m-cu*.

Greater robustness of hypopygium, with some of the parts presenting a different shape.

Stem of R_{2+3} about equal to R_2 and not very much longer, as in *flavicollis*.

D. TASMANIENSIS, n.sp.

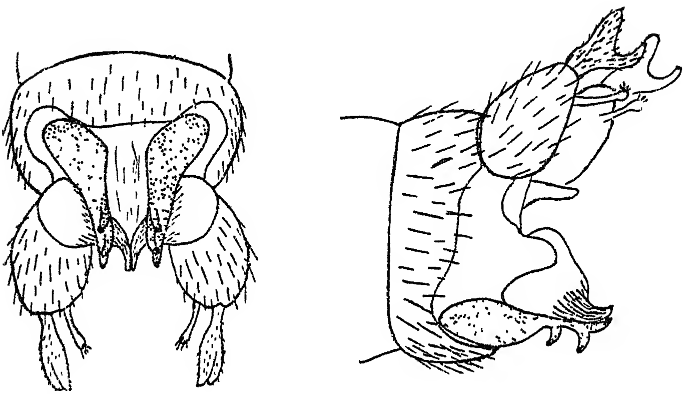


Fig. 3. Hypopygium of *D. tasmaniensis* from below and from the side.

Male: Head shining black, proboscis yellow, palpi and antennæ black, but the scape a little lighter on the side. Mesonotum yellowish-orange with three brown-black bands, confluent anteriorly, the median one divided by a very thin line, and shortened behind so as to leave a large yellow space in front of the scutellum, which is also yellowish, except on the sides; post-scutellum black; pleuræ blackish, lighter below the base of the wings. Front coxæ brown at base, yellowish at tip as well as the others, and the base of femora, which are more or less testaceous on their whole length, their tip being distinctly black; the middle femora are somewhat darker; tibiæ and tarsi brownish, the hind tibiæ a little lighter, chiefly at base. Base of stem of halteres yellowish, then dark, and the knob again yellowish. Abdomen black, moderately shining; hypopygium also black, the claspers lighter; wing greyish with a moderately marked brown spot extending from the base of Rs towards fRs and *r-m*, also a slight shadow near the extremity of Cu.

The antennæ are as long as the abdomen at least, and very thin towards the end; the joints are elongated, cylin-

drical, indistinguishable from each other, especially towards the end; relative length of palpal joints as in preceding species.

Venation: *r-m* placed after fRs; stem of R_{2+3} only a little shorter than R_2.

Hypopygium: Side pieces moderately long with an internal pre-apical thin process about as long as the claspers and swollen at tip, which carries three or four small bristles, two of which are stouter; claspers broad, triangular, ending in two branches separated by a semi-circular notch, the inferior branch curved upwards and with its tip black, strongly chitinous; the two lateral inferior pieces of the ædœagus dark and with three hooky spines, two pointing downwards and the terminal one upwards.

Wing length: 3 1-3 mm.

Female: Colouring exactly the same as in male; stem of Rs relatively shorter, wing marking more intensive, especially the shadow around the extremity of Cu.

Type and allotype from Mt. Wellington, Tasmania, 25th November, 1922. In the collection of the Cawthron Institute. A dozen paratypes from the same locality and from Hartz Mt., 9th December, 1922; Burnie, 31st January, 1923; Eagle-Hawk Neck, 15th November, 1922; Mt. Field, National-park, 18th December, 1922; Mt. Farrell, 9th February, 1923. All these localities in Tasmania.

D. NICHOLSONI, n.sp.

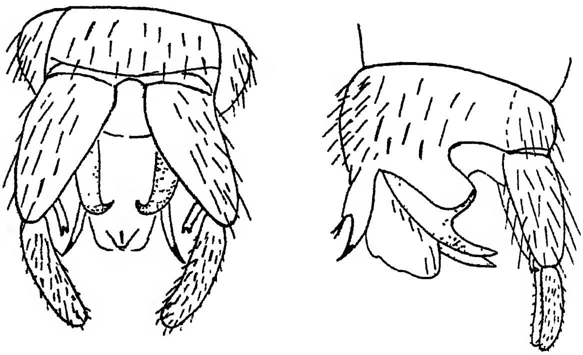


Fig. 4. Hypopygium of *D. nicholsoni* from above and from the side.

Male: Head with appendages dark brown; mesonotum with three confluent broad dark bands which leave only very little dull ferruginous colour on the sides and before the

scutellum, this and post-scutellum obscurely ferruginous. Pleuræ with exception of sternopleuræ testaceous-orange, as well as all the coxæ; legs brownish, the femora slightly lighter. Base of stem of halteres testaceous, the rest and the knob brown. Abdomen black, more or less shining, with dark scarce pubescence; hypopygium ferruginous; wings grey with a very indistinct smoky marking on fRs and *r-m*.

Antennæ filiform as in preceding species; palpi also similar.

Venation: Origin of Rs in front of the end of Sc, *r-m* placed after fRs; stem of Rs equal to stem of R_{2+3}

Hypopygium: Side pieces with an internal pre-apical process of moderate length and bifid at the end; claspers cylindrical without any spines, hooks, or bristles, their ends blunt; ædœagus complicated, presenting two downward pointing processes (2) ending in a sharp black spine and presenting a small tuft of hair at base of this spine, the internal parts of the ædœagus in form of two strong hooks pointing upwards.

Wing length: 3 mm.

Female: The colouring seems to agree well with that of male as far as it is possible to judge from alcohol specimens; there is agreement in all morphological details.

Type and allotype from Mill, Allyn River, N.S.W., 18th December, 1922. In the collection of the University, Sydney.

Nineteen paratypes in spirit collected in the same locality at the same date, by Mr. A. J. Nicholson, who found these flies clustered on stones.

D. HUMERALIS, n.sp.

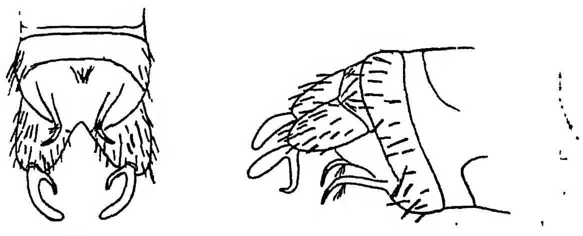


Fig. 5. Hypopygium of *D. humeralis* from below and from the side.

Male: Very similar to *D. nicholsoni*, but its general colouration very much darker. The thorax, which is rather

(2). The hypopygium of *Dixa* as in most *Culicoidea* is inverted, the tergum being situated ventrally.

shining, is only yellow-orange at the shoulder and at inferior part of the mesosternum; halteres uniformly dark yellowish; all coxæ yellowish, the femora also, but with dark tip; anterior tibiæ brownish, the hind one yellowish, with dark, moderately swollen extremity; tarsi brown; wing nebulous, with a rather strongly marked roundish spot near the base of Rs, and extending on fRs and *r-m*, a slight infuscation on the whole wing tip from the level of fR_{2+3}, but extending more towards the base of R_{4+5}, a slight infuscation also at base of the anal area, then under the first half of Cu and on both sides of the extremity of Cu.

Antennæ and palpi as in preceding species.

Venation: Origin of Rs after the tip of Sc; stem of Rs shorter than the stem of R_{2+3}; *r-m* placed at fRs; stem of R_{2+3} a little shorter than R_2.

Hypopygium: Small, the side pieces *without* any internal process, the claspers bifid, the upper branch blunt, the inferior one thinner, curved upwards, and with a black hard tip; the ædœagus with two downward directed long, thin, yellow hooks, with a dark tip, and carrying some short hair in tuft on the middle of their inferior side.

Wing length: 2½ mm.

Female unknown.

The type, a unique specimen, was collected on Mt. Wilson (Blue Mts., N.S.W.), 20th November, 1921, and is in the collection of the Cawthron Institute.

D. UNIPUNCTATA, n.sp.

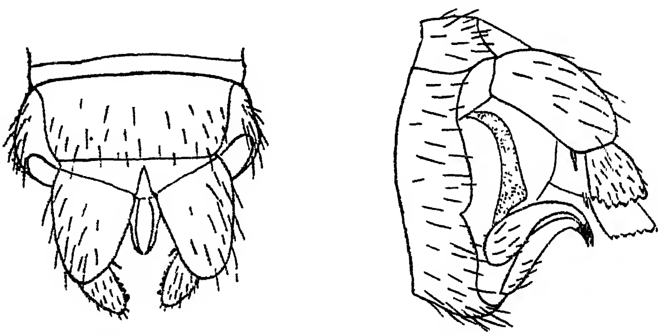


Fig. 6. Hypopygium of *D. unipunctata* from above and from the side.

Male: Clypeus yellowish, palpi brown, antennæ with the scape brown, flagellum black; vertex shining black. Thorax orange-yellow, with the exception of the prothorax, which is dark; three dark disconnected bands on mesonotum; a very wide dark band across the pleuræ from the anterior coxæ to the base of the abdomen; all coxæ yellow, also the femora, especially at base, the hind ones completely, except for the tip, which is black, whereas the anterior ones become gradually darker towards the tips; anterior tibiæ brownish with dark tip, the hind one yellowish with black moderately swollen extremity; tarsi blackish; halteres completely orange-yellow. Abdomen brownish black, rather dull, hypopygium slightly brownish, wing greyish with an infuscated roundish spot on the last half of the stem of Rs on fRs and *r-m*, also a very indistinct shadow on the last part of Cu.

Antennæ elongated as in preceding species, and relative length of the palpal joint similar.

Venation: Origin of Rs not much after the tip of Sc, *r-m* placed a little after fRs; stem of Rs about equal to stem of R_{2+3}, the latter about half the length of Rs.

Hypopygium: Small, side pieces with a very small inconspicuous internal distal process, which looks like a small spine, but is composed of a cylindrical basal part on which are inserted two small bristles; claspers about half the length of the side pieces, axe-shaped, their outer edge serrated; ædœagus with two conspicuous orange hooks pointing downwards with black tip.

Length of wing: 3½ mm.

Female unknown.

Type from St. Patrick's River, Tasmania, 1st November, 1922. In the collection of the Cawthron Institute. One paratype from the same locality and date.

LARVÆ.

The three larvæ which have been secured up to now are not referred to the three particular species by way of rearing, but only by simultaneity of capture of the imagines in the same spot where the larvæ had been found. Therefore their identity remains somewhat dubious, although in each case only one species of the adult had been found at the same time with the larvæ hereafter described. None of the pupæ are known.

TABLE OF KNOWN LARVÆ.

1. Dorsum of abdominal segments 2-7 carrying a conspicuous crown of hairs; armature of spines present only on the abdominal sternite 5 and 6 *D. GENICULATA*, Tonn.

   The abdominal segments without crown of hairs; armature of spines present on the abdominal segments 5-7 2.

2. Base of the lateral plates of the spiracular armature connected by a chitinous plate; spiracles round; caudal appendage not much longer than the lateral plates. *D. TASMANIENSIS*, Tonn.

   The lateral plates not connected between them at base; spiracles elongated; caudal appendage distinctly longer than the lateral plates. *D. NICHOLSONI*, Tonn.

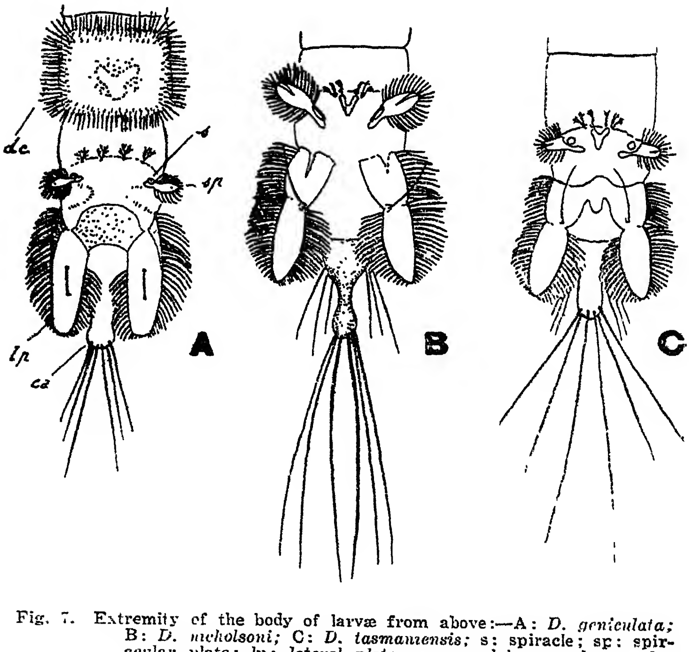


Fig. 7. Extremity of the body of larvæ from above:—A: *D. geniculata;* B: *D. nicholsoni;* C: *D. tasmaniensis;* s: spiracle; sp: spiracular plate; lp: lateral plate; ca: caudal appendage; dc: dorsal crown of hairs.

DIXA NICHOLSONI, Tonn.

The full-grown larva is 8 mm. long, its colour grey with brown diffused markings on the dorsum.

Head black with ferruginous parts chiefly on the sides.

Antennæ with the usual short triangular spines, without hairs, carrying only one small external bristle inserted about one-third before the extremity. Mandibles and maxillæ of the usual type, these last conical and as long as the maxillary palpi. Mentum bluntly conical without any distinct indentation. Labrum with two rather well developed tufts of hairs.

Anterior edge of prothoracic sternite with a row of very long bristles reaching beyond the head; four of them are disposed in a tuft, and are, with the others, in the following order: 1.1.1.1.4.1.-1.4.1.1.1.1. The two pairs of pseudopods of the two first abdominal segments are equally developed. The armature of spines on the sternum of abdominal segments 5-6 are composed of two groups of two juxtaposed rows of spines, containing each 7 spines pointing backwards, the spines of the upper row being much stronger than those of the inferior row; on the 7th segment the groups are composed only of rows of 5 spines; the two groups of rows are separated by a small longitudinal chitinous band. The basal sternal plate of the caudal appendage has two groups of three rather long bristles reaching beyond the end of the caudal appendage, which is black, and carries six long bristles at its extremity.

The structure of the spiracular plates, as in figure 7B; the spiracles themselves elongated; between them there is a chitinous armature in shape of a V surmounted on each side with three tufts of small curved hairs. The lateral plates are not connected at their base by a chitinous structure; their comb, situated on the middle of their inferior side (the lateral side of the body), is formed by a regular row of moderately developed spines, the last of which is stronger than the others.

DIXA TASMANIENSIS, Tonn.

Length of full-grown larva 6 mm.; it is very similar to the larvæ of the preceding species; its colouration is the same, and its whole body is also covered with a microscopical but very dense pubescence. Head mostly ferruginous, blackish above and with a black posterior edge. Antennæ with the usual short spines, and besides the external small bristle,

which is nearly median, they carry on the ventral side a number of hairs. Labrum with well-developed dense tufts of hairs. Maxillæ conical as in preceding species, but without hair at its extremity; the palpi with rather larger spines on the internal side. Mentum without distinct indentation.

Anterior border of prothoracic sternum with moderately long black bristles pointing forward and not reaching beyond the head; they are disposed according to the following order, four of them making a tuft on each side: 1.1.1.4.1.-1.4.1.1.1. The two outer ones on each side are only half the size of the others. The armature of spines on the sternum of abdominal segments 5-7 are as in the preceding species as to number and disposition; the spines, however, are relatively longer, and between the two groups there is no chitinous longitudinal small plate.

The sternal basal plates of the caudal appendages with two groups of three moderately long bristles; the caudal appendage, which is testaceous and relatively small, carries six long black bristles about twice as long as the appendage itself.

Spiracular plates according to figure 7C; the spiracles themselves are roundish; the V-shaped structure between them is provided with two groups of three small tufts of curved hair as in preceding species. The bases of the lateral plates are connected with each other by a chitinous formation; their inferior comb is composed of a row of very small spinules which end in a relatively large trifid spine.

DIXA GENICULATA, Tonn.

Length of full-grown larva 6½ mm. Its colour is of a dirty yellowish, the dorsum darker on account of the long hairs of the abdomen; head testaceous with a black anterior and posterior edge above. Antennæ and palpi black; labrum with the usual dense, well-developed tufts of hair; mandibles as usual, maxillæ also, pointed, with only a few hairs at the tip. Antennæ without hairs or bristles, only with the short triangular spinules. Mentum without distinct indentation.

No conspicuous bristles on the anterior edge of the prothoracic sternum; the first pair of abdominal prolegs more developed than the second; armature of hooks present only on the 5th and 6th abdominal segments, and composed of two adjacent groups of spines in two juxtaposed rows, the inferior one being formed of six straight thin spines, the

superior one of five closer somewhat falcate spines, no chitinous small plates between the groups of spines. All round the dorsum of abdominal segments 2-7 there is a conspicuous crown of stiff hairs which are more developed on the sides than anteriorly or posteriorly. Basal sternal plate of caudal appendage without conspicuous bristle, the caudal appendage, which is short and testaceous, is provided with six black terminal bristles, only a little longer than the appendage itself; lateral plates connected at their base by a chitinous plate; their median bristle is coarse and branched at the tip.

The spiracular plates according to figure 7A; the spiracles themselves round, separated by a row of four little groups of branched hairs.

NOTES ON AUSTRALIAN *BOMBYLIIDÆ*, MOSTLY FROM THE MANUSCRIPT PAPERS OF THE LATE ARTHUR WHITE.

By G. H. Hardy.

(Read 6th August, 1923.)

The manuscript papers of the late Arthur White are in the possession of Dr. E. W. Ferguson, to whom I am indebted for permission to publish original matter contained therein. These manuscripts consist of (1) contributions that have already been published; (2) a very large mass of compiled notes and descriptions, interspersed amongst which are (3) a few pages of original material that have not been published, and that contain certain information based upon the examination of Walker's types in the British Museum.

Notes on the types of earlier described species are of utmost importance, but White limited his observations almost entirely to those characters that he could use in keys, and often a number of species included by him under a genus also include some he has never seen. It is difficult to judge how much of the keys is based on observation and examination of the type material, and how much on compilations from other works.

Owing to this confusion, White's manuscript cannot be compiled into a condition suitable for publication as an independent paper. I have therefore considered it advisable to publish White's records with my own, and to accept that which appears to me to be original, and within the probability of being correct.

The keys and notes taken from White's manuscript are indicated so that it can be readily understood how much of my paper is to be attributed to White's researches.

So far only manuscript containing *Bombyliidæ* and *Nemestrinidæ* has been found to contain unpublished matter, and from the information given in the former family, I find it necessary to amend my catalogue on the *Bombyliidæ* which was previously published in these Proceedings; some alterations which are the result of other researches are also included. White's key to the *Nemestrinidæ* is given elsewhere.

ANTHRACINÆ.

Genus HYPERALONIA, Rondani.

White's manuscript.—"Table of the Australian Species of Hyperalonia.

1. Wings not spotted. 2.
   Wings spotted. 3.
2. Abdomen black, apex silvery; wings blackish with base yellow, tips hyaline. *funesta*, Walker.
3. Abdomen black with golden or white bands near the base; wings spotted with foremargins yellow. *bombyliformis*, Macl. =*Exoprosopa punctipennis*, Macq.
   Wings with foremargins brown, with small spots below and towards base. *silvanus*, Fabr.

All the above were described under the genus *Anthrax*. *Hyperalonia argenticincta*, Bigot, is unknown to me, but I suggest that it is probably the same as *H. bombyliformis*, Macleay."

Observations.—*H. funesta*, Walker, is the same as my *H. satyrus*, Fabricius, but from White's key this is scarcely apparent. Apparently *Bibio sylvanus*, Fabricius, was only known to White from the description, and he followed Walker's identification for this species, or possibly he took his characters in the key from the original description; I have already associated the species with the genus *Comptosia*, and do not see any reason to alter my opinion.

The distinguishing characters of the four described species as recognised by me are as follows:—

H. satyrus, Fabricius. A black species with only three pairs of white spots at the apex of the abdomen. A closely allied species (apparently undescribed) has an extra pair near the base.

H. bombyliformis, Macleay. A species with four fuscous spots on the wing. This is the only large species known to me with this character; the abdomen varies in the amount of silvery tomentum on it so that some unusually light forms may be mistaken for new species.

H. cingulata, v.d. Wulp. A species that has the wings with the anterior border for two-thirds the length, and an isolated blotch at apex of the second basal cell, fuscous.

H. sinuatifasciata, Macquart. A species with the same wing character as *H. cingulata*, v.d. Wulp, except that the whole of the second basal cell and the apex of the discal cell are fused with fuscus.

Genus EXOPROSOPA, Macquart.

White's manuscript.—"*Table of Australian Species of Exoprosopa.*

1. Abdomen shining blue. *marginicollis*, Gray.
 Abdomen black or brown. 2.
2. Wings brown, with tips hyaline. *stellifer*, Walker.
 Wings brown with apex very broadly hyaline and with large hyaline indentations below. *adelaidica*, Macquart.
 Wings hyaline with the base, costa, and two oblique stripes brown. *obliquifasciata*, Macq. (unknown to me).

Exoprosopa laterimbata, Bigot, I cannot at present place. *E. punctipennis*, Macquart, is a *Hyperalonia*. *E. bicellata*, Macquart, is of doubtful position."

Observations.—I am not certain if *E. laterimbata*, Bigot, as identified by myself, is not a colour variation of *E. stellifer*, Walker; I have re-examined the specimens together with the variation of *E. stellifer*, and failed to find a satisfactory character other than the general black and brown abdomens respectively, to distinguish these species.

Exoprosopa marginicollis, Gray.

Anthrax marginicollis, Gray, in Griffith's Animal Kingdom, xv., Ins. ii. 1883, p. 780; pl. cxxv., fig. 6.

This species, new to my list, was described without a locality. Gray states that it "has the thorax green with a "white line on each side; the body blue, the wings diaphanous "with the anterior part and base black." In the Macleay Museum there are several specimens which are undoubtedly this species, but all are entirely metallic blue, except one, and that has a metallic green abdomen showing that either the blue and green are interchangeable, or the latter is a discoloration.

Genus ANTHRAX, Scopoli.

White's manuscript.—"*Table of Australian Species of Anthrax.*

1. Wings at least half brown. 2.
 Wings hyaline with at most the costal margin brown. 5.
2. Wings cut sharply in a nearly straight line into a deep brown basal half, and a hyaline apical half. *incisa*, Macq.

Wings cut sharply into a basal and hyaline half, the dividing line being greatly sinuated so that the prolongations of the brown encroach on the hyaline portion. *concisa*, Macq.

Wings with the base and costal half suffused with brown, which melts gradually into the hyaline portions without any distinct line of demarcation. 3.

3. Scutellum testaceous, abdomen with the sides testaceous. *obscura*, Macq.

Scutellum black. 4.

4 Abdomen with two white bands. *alternans*, Macq.

Abdomen with white spots. *commista*, Macq.

5. Wings completely hyaline, pubescence at sides of thorax yellowish white, small species. *minor*, Macq. = ?*vitrea*, Walk.

Wings practically hyaline, but a little darker along the course of the closely adjacent mediastinal and subcostal veins; pubescence at sides of thorax fulvous, small to middle sized species. *nigricostata*, Macq.

Wings hyaline; yellow haired species; abdomen with black hairs on sides of fourth and fifth segments; large species. *flaveola*, Macq.

Wings hyaline, but largely suffused with brown from the base; large species. *albirufa*, Walk.

Wings hyaline with base and costal margin brown. 6.

6. Large species (usually about 12 mm.) 7.

Small species (5 to 8 mm.) 8.

7. The brown colouration on the foremargin never descends so far as the bifurcation of the radial and cubital veins, which are always clear; the black pubescence on sides of abdomen is confined to the third and subsequent segments, that on the second basal segment being pale yellow. *marginata*, Walk. = ?*fuscicostata*, Macq.

The brown colouration of the foremargin covers the bifurcation of the radial and cubital veins; the black pubescence on the sides of the abdomen commences on the second segment. *velox*, White.

8. Pubescence at base of abdomen yellowish-white; wings rather dull. *simplex*, Macq.

(*A. pellucida*, Walker, belongs here, but I cannot say whether or not it is distinct.)

Pubescence at base of abdomen bright silvery white; wings bright glistening. *argentipennis*, White.

The type of *A. tasmanica*, Walker, in the British Museum collection is in too bad condition for identification. The types of the following three species are not to be found in the B.M. collection:—

A. alterna, Walker, *A. resurgens*, Walker, and *A. subsenex*, Walker, and it is impossible to say to what genera they belong."

Observations.—In a marginal note of a compiled note on *Anthrax incisa*, White wrote "Doubtfully an *Anthrax*"; in my catalogue I have suggested that it should come under the genus *Argyramœba*. Under this same genus I have placed *A. concisa*, Macquart.

A. tasmanica, Walker, is apparently a manuscript name, as I have failed to find any published reference to it, and White did not include any notes upon it under his compilations.

A. subsenex is referred, in this paper, to the genus *Comptosia*.

Genus CYTHEREA, Fabricius.

Glossita lipposa, Bigot, was placed by White in his manuscript under the genus *Mulio*, Latrielle, but he added in brackets "this species is unknown to me."

Genus ARGYRAMŒBA, Schiner.

White's manuscript.—"Table of Australian Species of Argyramœba.

1. Wings mostly deep black. 2.
   Wings mostly hyaline. 3.
2. Abdomen black with apex silvery white. *maculata*, Macq.=*australis*, Walk.
3. Wings with base and basal part of foremargin brown, and three brown spots, there being one at apical end of discal cell. *incompta*, Walk.
   Like *incompta*, only without any spots at apical end of discal cell. *semimacula*, Walk.

(All the above were described under the genus *Anthrax*.)"

LOMATIINÆ.

White's manuscript.—

"Genus COMPTOSIA, Macquart.

This genus was originally described by Macquart as possessing three submarginal cells, the type of the genus being *C. fascipennis*, Macquart, from Australia, but given in error from Monte Video; afterwards, however, Macquart placed in this genus species possessing only two submarginal cells.

Table of Australian Species of Comptosia.

1. Three submarginal cells. 2.
   Two submarginal cells. 7.
2. Wings brown, but the tips may be hyaline, and some hyaline spots may be present. 3.
   Wings hyaline, with only the costal margin narrowly or broadly brown. 6.
3. Scutellum red. 4.
   Scutellum brown or black. 5.
4. Wings dark brown with very distinct white tip; abdomen long, very large species. *fuscipennis*, Macq.=*insignis*, Walk.
   Wings entirely pale brown, or with tips indistinctly hyaline; abdomen short, large species. *decedens*, Walk.=?*basilis*, Walk.
5. Wings completely brown on which are darker small brown spots; small species. *serpentiger*, Walker.
6. Wings with foremargins very broadly and irregularly brown, narrowest in the middle, and with a long hyaline spot towards the tip; no brown spots present; small species. *dorsalis*, Walk.
   Wings with foremargins brown, and many small brown spots; small species. *plena*, Walker.
   Wings with foremargins broadly and irregularly brown, and four brown spots below; medium sized species. *corculum*, Walk.=?*tricellata*, Macq.
7. Wings entirely brown; large species. *aurifrons*, Macq.=*extensa*, Walk.
   Wings brown with the tips white. 8.
   Wings hyaline with foremargins brown. 9.
8. The brown portions of the wings containing hyaline spots. *maculipennis*, Macq.=*ocellata*, Walk. =*inclusa*, Walk.=*cognata*, Walk.

The brown portion of the wing has the base and band across the middle hyaline. *tendens*, Walk.

The brown portions of the wings contain no band or spots, but the base of the wing is hyaline, and the brown portion pale. *quadripennis*, Walk.

The wings with the exception of the white tips are wholly dark brown; a rather small species. *præargentata*, Macleay.

(*fasciata*, Fabr., according to my description, agrees with *præargentata*, Macl.)

The wings like those of *præargentata*, but not so dark; a much larger species. *stria*, Walk.

9. Hyaline portion of the wing without any brown spots. 10.
Hyaline portion of the wings with brown spots. 11.

10. Wings quite hyaline, except for narrowly brown costa. *sobricula*, Walk.

Wings faintly tinged with brown, costa more broadly brown than in *sobricula;* rather large species. *sobria*, Walk.

Costal half of wing suffused with brown; very small species. *partita*, Walk.

11. Abdomen very broad, with side-tufts of black and white hairs; wings with foremargins brown, and brown diffused spots below; large species. *patula*, Walk.=*plana*, Walk.=*ampla*, Walk.

Abdomen narrow, without side-tufts of black and white hairs; wings with foremargins broadly brown, and four small brown spots below; medium sized species. *geometrica*, Macq.=*obscura*, Walk.

The following species I am not at present able to identify:—*C. bicolor*, Macq., and *C. fulvipes*, Bigot. Bigot's *Lygira rubrifera* is probably a *Comptosia*."

Observations.—This part of White's manuscript is exceedingly valuable, in so far as it elucidates various descriptions previously found too inadequate to allow for a determination of the species. White's group *Comptosia* is equivalent to my *Lomatiinæ*, under which I have placed it. I have divided the group into three genera, all of which need adjusting. My *Lomatia subsenex* is now referred to *Comptosia* proper.

Oncodocera plana, Walker.

Anthrax plana, Walker, List Dipt. B.M., ii., 1849, p. 272 and Ins. Saund. Dipt., 1852, p. 168.

Oncodocera plana, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 54.
Anthrax patula, Walk., *ibidem*, 1849, p. 273; and 1852, p 168.
Oncodocera patula, Hardy, *ibidem*, 1921, p. 53.
Anthrax ampla, Walker, Ins. Saund. Dipt., 1852, pp. 167-185.
Oncodocera ampla, Hardy, *ibidem*, 1921, p. 53; pl. xvii., fig 11.

Synonymy.—The above synonymy is given on the authority of White's manuscript.

Comptosia plena, Walker.

Observation.—If the characters given in White's key are accurate, my determination of *Anthrax plena*, Walker, is wrong, but a further comparison with Walker's description leads me to believe otherwise, and on this account I think it is possible that White extracted his characters from the description, and did not base his remarks upon specimens.

Comptosia fasciata, Fabricius.

Anthrax fasciata, Fabricius, Syst. Antl., 1805, p. 118.
Comptosia fasciata, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 57, which see for further references, and synonymy.
Anthrax præargentata, Macleay, in King's Narr. Surv. Austr., ii., 1832, p. 468. *Id.*, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 60, which see for further references.

Synonymy.—White probably based his identification of *Anthrax præargentata*, Macleay, upon a specimen identified by Walker. The whereabouts of the type is not known, so it seems advisable, for the time being at least, to accept White's statement "*fasciata*, Fabr. according to my description "agrees with *præargentata*, Macl.," to be the probable solution to Macleay's species. *A. fasciata*, Fabr., is not referred to elsewhere in White's manuscript, so the details of White's description are unknown.

Comptosia fascipennis, Macquart.

Comptosia fascipennis, Macquart, Dipt. Exot., ii., 1, 1840, p. 80; pl. fig. *Id.*, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 54.
Neuria lateralis, Newman, Entom., i., 1841, p. 220.
Comptosia lateralis, Hardy, *ibidem*, p. 58, which see for further references and synonymy.

Synonymy.—According to the information given by White in his manuscript, this name, *C. fascipennis*, Macquart, must be given the preference over *C. lateralis*, Newman. I do not know from where White could have secured his in-

formation. as apparently Macquart did not correct the original locality which was "? Monte Video."

Comptosia extensa, Walker.

Anthrax extensa, Walker, Ent. Mag., ii., 1835, p. 473; and List Dipt. B.M., ii., 1849, p. 269. *Id.*, Hardy. Proc. Roy. Soc. Tasm., 1921. p. 60.

Neuria extensa, Newman, Entom., i., 1841, p. 221. *Id.*, Walker, Ins. Saund. Dipt., 1852, p. 167.

Comptosia aurifrons, Macquart, Dipt. Exot., suppl. 4, 1850, p. 113; pl. x, fig. 16. *Id.*, Hardy, Proc. Roy Soc. Tasm., 1921, p. 59.

Synonymy.—The above synonymy is probably correct; White stated it to be so in his manuscript, and the descriptions conform rather well.

Correction.—In my catalogue, in the note under *C. aurifrons*, for "front" read "face."

Comptosia basilis, Walker.

Anthrax basilis, Walker, List. Dipt. B.M., ii., 1849, p. 267. *Id.*, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 60.

Neuria basilis, Walker, Ins. Saund. Dipt., 1852, p. 167.

Anthrax decedens, Walker, List Dipt. B.M., ii., 1849, p. 271. *Id.*, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 60.

Neuria decedens, Walker, Ins. Saund. Dipt., 1852, p. 167.

Synonymy.—The above synonymy is given on the authority of White's manuscript.

Note.—From White's key and the descriptions, I am able to recognise as this species three specimens which are from Perth, Western Australia, and which are in my collection; they were captured during November, 1912.

Comptosia subsenex, Walker.

Anthrax, subsenex, Walker, Trans. Ent. Soc. Lon., iv., 1857, p. 144.

Lomatia? subsenex, Hardy, Proc. Roy. Soc. Tasm., 1922, p. 52.

Status.—Previously I had overlooked the line above the description where Walker referred this species to his group 8. This reference places the species amongst the true *Comptosia*, and I am now able to identify it with a common Sydney species which was previously unnamed in collections.

Description.—A rather large uniformly blackish brown species with soft whitish pubescence laterally, and covering the whole ventral surface.

Male.—Eyes approximate; ocellar triangle with some rather long black hairs; antennal triangle black, with black hairs and some light tomentum, especially along the eye margins. The face is covered with shining white tomentum that is slightly stained yellow near the antennæ, which have abundant black hairs on the basal segment. The dorsal surface of the thorax is covered with brown tomentum; there are traces of white tomentum at the sides. About six bristles are situated anteriorly to the insertion of the wings, and a group of about six more are on the postalar callus, but the presence and number of these bristles depend largely upon the condition of the specimen. The abdomen is uniformly brown, with a trace of a margin of white hairs at the apex of each segment, but more intensified on the first. The legs are reddish brown. The wings are uniformly suffused brown with reddish brown costal margin and veins. There are only two submarginal cells, and the upper branch of the cubital vein has a stump-formed appendix.

Female.—The characters of the female are similar to those of the male, from which it differs in the separated eyes; the front is similar to the frontal triangle of the male in colour and pubescence, and the face shows more yellow, tending to golden, hairs below the antennæ.

Length: 12-15 mm.

Hab.—New South Wales; Blackheath, November, 1919, and Como, October, 1921.

Type.—The type, according to White's manuscript, is not to be found in the British Museum, and presumably it is lost. The specimens described above, a pair in my own collection, were taken at Blackheath on the 21st November, 1919. There are four other pairs taken in copula, and a further seventeen specimens in the series examined.

Note.—This species is similar to *C. extensa*, but differs in having white instead of yellow pubescence; the loop of the radial vein is not quite so long, and the presence of the appendix on the cubital vein will also serve as a more or less reliable distinguishing character. From *C. ducens* and *C. sobria*, it differs in the absence of the cross vein between the radial and cubital veins as well as in colour and other details.

SYSTROPINÆ.

Genus SYSTROPUS, Wiedemann.

Note.—Amongst White's manuscript there is the description of a species for which it was intended to give new generic and specific names. I have seen in the Melbourne Museum specimens of the same species and they are closely allied to and certainly cogeneric with my *Systropus clavifemorata.* White's description was based upon two male specimens sent by Mr. F. P. Spry, and were from Belgrave and Gippsland, Victoria. Names were not given in the manuscript, and although White stated "Gen. nov. allied to "*Systropus,*" he did not give particulars of what he considered to be the characters of his proposed new genus whereby it can be distinguished from *Systropus.*

BOMBYLIINÆ.

White's manuscript.— . . . . (Here comes a key to the genera of the *Bombylius sensu lato,* which has already been published by White in these proceedings). . . . . .

"Great variation is shown in the amount of curvature "of the radial vein, but this appears to be a specific char- "acter only. I have examined all Walker's type species, ex- "cept *B. areolatus,* but the following four species of Macquart "are unknown to me, and I cannot at present place them:— "*Bombylius consobrinus, pencillatus, pictipennis* (should be "easily identified by the markings of the wings), and *tenui-* "*cornis,* Macq. Of the two following, I have not the descrip- "tions:—*B. australianus* and *rubriventris,* Bigot.

Genus DISCHISTUS, Loew.

The first posterior cell open; first basal cell much longer than the second basal cell.

Table of Australian Species of Dischistus.

1. Minute species, dark with whitish pubescence; radial vein straight. *antecedens,* Walker.
   Larger species. 2.
2. Broad tawny species; radial vein much upturned; wings tinged yellow. *altus,* Walker =*pinguis,* Walker.
   Yellow species; radial vein moderately upcurved; wings practically hyaline. *immutatus,* Walker.

Observations.—Of Walker's nine species placed by me under the genus *Sisyromyia,* four are placed by White under *Dischistus.*

Dischistus antecedens, Walker.

Bombylius antecedens, Walker, List Dipt. B.M., ii., 1849, p. 293.
Sisyromyia antecedens, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 72.

Dischistus altus, Walker.

Bombylius altus, Walker, List Dipt. B.M., ii., 1849, p. 288.
Sisyromyia altus, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 72.
Bombylius pinguis, Walker, List Dipt. B.M., ii., 1849, p. 290.
Sisyromyia pinguis, Hardy, *ibidem,* 1921, p. 72.

Note.—The species labelled by me *Sisyromyia pinguis* in the Macleay Museum cannot be identical with Walker's species, if the information gathered from White's manuscript is correct.

Dischistus immutatus, Walker.

Bombylius immutatus, Walker, List Dipt. B.M., ii., 1849, p. 292.
Sisyromyia immutatus, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 72.

Genus SYSTŒCHUS, Loew.

White's manuscript.—"First posterior cell closed; first and second basal cells of almost equal length.

Table of Australian Species of Systœchus.

1.	Apex of abdomen with a tuft of dark brown pubescence on each side; abdomen with a brown band across the middle.	2.
	Apex of abdomen without side tufts of pubescence; abdomen not banded.	3.
2.	Pubescence of abdomen pale brown.	*crassus,* Walk.=*platyurus,* Walk.
	Pubescence of abdomen white.	*vetustus,* Walk.=?*sericans,* Macq.
3.	Pubescence of abdomen golden.	*distinctus,* Walk."

Observations.—It is possible that *Choristus* will have to take the place of *Systœchus,* but as the type species is not known to me, I refrain from changing the names for the present. White seems to have overlooked *Choristus bifrons,* Walker, as his manuscript is without reference to it.

Systœchus australis, Guerin.

Bombylius australis, Guerin, Voy. Coq. (2) ii., 1830, p. 294; pl. xx., fig. 4. *Id.*, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 75.

Note.—According to the description and illustration, this species could be either a *Bombylius* or *Systœchus*. Four specimens of the latter genus, from Sydney, agree with the curvature of the radial vein. and with the very long palpi, both of which characters in the illustration are unknown to me within the genus *Bombylius*. Other characters given in the illustration are not reliable, and are due to inferior drawing; even the colour is unsatisfactory, as the copy of the work in the Australian Museum shows the insect to be uniform, and dark in colour, whilst that in the library of the Linnean Society shows a brighter insect, with light stripes at the sides of the thorax.

I propose to utilise the name for four specimens (3 ♂ ♂, 1 ♀) which are in my collection, and were taken in the vicinity of Sydney. These specimens differ from the illustrations in colour, but agree with the description and the illustration moderately well, allowing for the inferior drawing, and they are the only specimens known to me in this or allied genera that have the very long palpi.

Genus SISYROMYIA, White.

White's manuscript.—"First posterior cell open; first and second basal cells of almost equal length.

Table of Australian Species of Sisyromyia.

1. Apex of abdomen with a tuft of black pubescence on each side. 2.
   Apex of abdomen without side tufts of black pubescence. 3.
2. Yellow haired species. *tetratrichus*, Walker.
3. Abdomen with a yellow or white centre stripe. 4.
   Abdomen without a centre stripe. 7.
4. Centre stripe bright yellow. *auratus*, Walk.=*crassirostris*, Macq.
   Centre stripe white. 5.
5. Wings with the costal half brown, remainder hyaline; legs altogether red; abdominal pubescence dark tawny. *decoratus*, Walker.
   Wings hyaline, or with only the costa brownish, and not clearly divided as in *decoratus*. 6.

6. Bright red-haired species.
rutilus, Walk.=?*albicinctus*, Macq.
Fulvous haired species. *albivitta*, Macq.
(Position doubtful, but probably belongs here).
7. Yellow haired species.
brevirostris, Macq.=*eulabiatus*, Bigot.
Type denuded, a small species from Swan River, resembling *brevirostris*, but costa more broadly brown, though not extending to the tip.
primogenitus, Walker."

Observations.—Four species, *pinguis*, *altus*, *antecedens*, and *immutatus*, Walker, which were placed in my catalogue under this genus, are now referred to *Dischistus*. White queried *B. albicinctus*, Macquart, to be the same as *B. auratus*, Walker, but Macquart states "abdomine albo fascialio . . . "quatrième segment de ce dernier a longs poils blancs au bord "antérieur . . . première cellule postérieur fermée . . . ," all of which does not agree with White's suggestion.

Sisyromyia auratus, Walker.

Bombylius auratus, Walker, List Dipt. B.M., ii., 1849, p. 289.
Sisyromyia auratus, Hardy, Proc. Roy. Soc. Tasm., 1921, p. 71, which see for further references and synonymy.
Bombylius rutilus, Walker, *ibidem*, p. 289.
Sisyromyia rutilus, Hardy, *ibidem*, p. 72.

Synonymy.—It seems evident from White's description that *B. rutilus*, Walker, is one of the forms placed by me under the name *Sisyromyia auratus*, Walker. Possibly further study will result in the separation of this series into more than one species, but there are no described characters that will enable this to be done at the present time. I have recently detected some differences in the palpi that possibly may be of specific value, but the material available for study is neither sufficient in numbers nor good enough in condition to verify the points.

Genus BOMBYLIUS, Linnæus.

White's manuscript.—"First posterior cell closed; first basal cell longer than the second.

Key to the Species of the Genus Bombylius.

1. Abdomen fringed posteriorly with white; wings with costal half brown, remainder hyaline.
hilaris, Walker.
Abdomen not fringed with white. 2.

2. Golden haired, very small species; abdomen without any black hairs. *chrysendetus*, White. *?nanus*, Walker.
   Fuscous haired species. 3.
3. Face in male narrow, about the width of one eye; legs pale red. *fuscanus*, Macq.
   Face in male broad, about the width of two eyes; legs dark reddish black. *palliolatus*, White.

The type of *B. matutinus*, Walker, is in too bad condition for identification; the face is narrow, and it can possibly be *fuscanus*. Another specimen named *matutinus* in the Museum collection is *B. palliolatus* and quite distinct from the type."

Observations.—White seems to have overlooked *B. viduus*, Walker, and he states that he did not see *B. aureolatus*, Walker. Both species have been recognised from their descriptions, and have been placed suitably in my catalogue.

No alterations can be made under the genus in my catalogue at present, but the discovery of a single specimen of *B. fuscanus*, Macquart, collected in the vicinity of Sydney, makes it desirable that three names of described species should be reconsidered, namely, *B. matutinus* and *tenuicornis*, Walker, and *B. consobrinus*, Macquart. *B. australianus*, Bigot, is undoubtedly the same as my identification of *B. tenuicornis*, Macquart, under which Bigot's name was placed as a synonym.

AN EXPERIMENTAL METHOD OF PRESENTING THE PRINCIPLES DETERMINING THE GENERAL PROPERTIES OF OPTICAL GRATINGS.

By A. L. McAulay, B.Sc., B.A., Ph. D.

(Read 6th August, 1923.)

In a laboratory which is not well equipped with modern optical instruments, the actual appearance and meaning of many of the phenomena whose theory is studied is not in the least appreciated. This seems especially the case in connection with the elements of the more advanced theory of optical gratings, and with the theory of interference spectroscopes.

The following presentation is an attempt to provide a set of experiments, made with fairly cheap and simple apparatus, which shall illustrate the various effects that produce the phenomena exhibited by an optical grating, and includes such simple theoretical discussion as is necessary to understand the experiments.

In the course of the experiments the effects that determine such things as the resolving power of a grating, the intensity of the spectrum of a given order, and so on, are directly observed. At the end of the paper the results obtained in the discussion are applied to the cases of the ordinary plane grating and the Michleson Echelon.

SECTION 1. APPARATUS.

The arrangement of apparatus is shown diagrammatically in Figure I. G is an ordinary metallic filament electric lamp of about 60 candle power, enclosed in a box which is fairly light tight; a kerosene tin lying on its side, with a black cloth over one end, and a window cut in the other serves the purpose very well. A is a vertical slit placed against the window. It should have good straight jaws, and be adjustable. Considerable use may be made of this adjustment, for some purposes it is convenient to have the slit very much wider than for others. It is best to have a large diameter short focus lens in the box to diffuse the light falling on the

slit. B is a short focus lens. It must be well corrected for chromatic aberration, as it must work with a fairly large diaphragm. A symmetrical camera lens by Beck of about 28 cms. focal length, working at F8, proved very satisfactory.

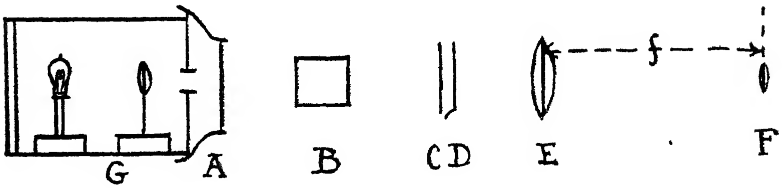


Figure I

C is another vertical slit. Its jaws must be good, and it should be fitted with a micrometer adjustment enabling its width to be measured. Otherwise, some such device as closing it on a piece of metal foil whose thickness is afterwards measured by a micrometer must be employed to determine its width. D is a wire grid, made by soldering together a metal rectangle, two sides of which are screws of fine pitch. Twenty-two gauge copper wire is wound round the rectangle over the screws, thus forming a double grid of the same pitch as the screws. The wire is next fastened to the rectangle with sealing wax, and the strands on one side cut away. In this way a grating of 22 lines, of pitch .76 mm., was made, and proved satisfactory. E is a telescope lens, corrected for chromatic aberration, of about a metre focal length. F is a micrometer eyepiece in whose field the phenomena to be described are observed, and by means of which distances on the diffraction patterns are measured. An ordinary eyepiece and scale could probably be made to serve.

SECTION 2. ADJUSTMENT.

A is opened to about a third of a millimetre, and B adjusted to render light from A parellel. C and D are removed, and E and F so arranged that A is sharply focussed along the vertical crosswire of F. B, E, and F should be sufficiently well corrected to give a brilliant image of A without striking aberrations.

SECTION 3. DIFFRACTION PATTERN DUE TO SINGLE SLIT. VISIBILITY CURVE.

The slit C is first completely closed, and then slowly opened. When its width is about .1 mm. the field of the eye-piece is seen to be slightly illuminated. On increasing its width the illumination increases, and at a certain stage dark vertical bands appear, one from each side of the field, and

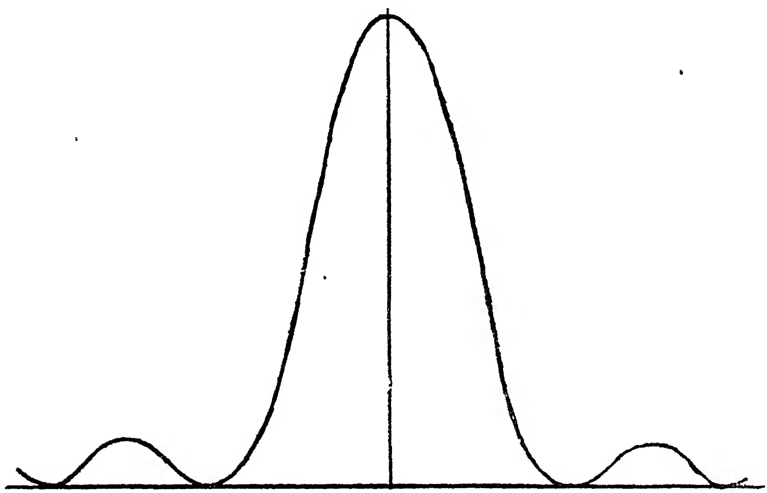


Figure II

move towards the centre. The slit is opened till it completely uncovers one aperture of the grid D, i.e., until its width is about .4 mm. The appearance is now as indicated in Fig. II., where abscissæ represent distances from the cross-wire of F, and ordinates the intensity of the light. This curve in what follows will be referred to as the visibility curve.

Measure the distance, f, from E to F, the width of the slit, e, and with the micrometer eyepiece the corresponding distance, 2d, between the first minima on the visibility curve. Repeat with three different slit widths, ending by opening the slit till one whole aperture of the grid is exposed. Show that in each case $d = \lambda f/e$, where λ is the mean wave length of the light used (about 6×10^{-5} cms.).

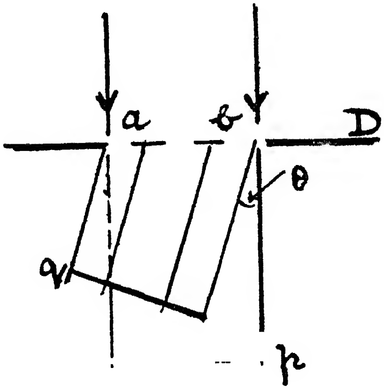
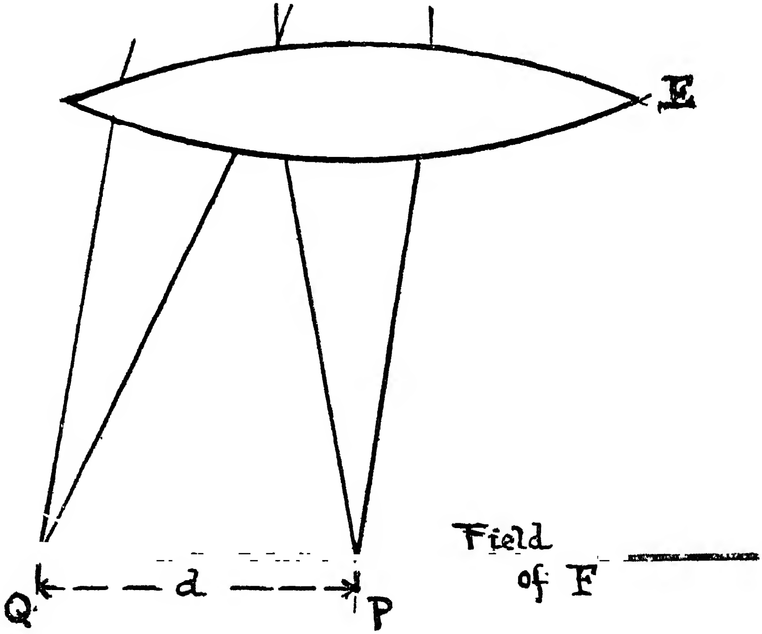


Figure III



SECTION 4. THEORY OF SECTION 3.

Figure III. shows diagrammatically the slit D and the lens E. Light falls on D normally, and therefore leaves every part of it in the same phase. Consider a beam leaving the slit at an angle θ with the direction of the incident light. The disturbances over a plane such as q perpendicular to this direction will be brought together by E at Q, the point at which a wave front at q would be focussed. The disturbances over q at any instant will, however, not be in exactly the same phase, and it is the combined effect of a set of out of phase waves that will produce the illumination at Q. Let p, P be the wave front, and focus for $\theta = 0$. It is obvious that this is the position of the image of the slit, that is, it is on the vertical crosswire as adjusted in section 3.

It is required to investigate the illumination at Q when Q takes up different positions. For this purpose the slit D will be thought of as made up of a large number of elements, and the combined effect of the wave trains from each will be considered. The waves arriving at Q will be represented as vectors in the usual way, and, as there are an equal number of wave lengths between each element of q and Q, a vector drawn for q will equally well stand for the effect of the same wave train at Q. a and b are two adjacent elements of the slit. Then obviously the path difference at q of the light coming from a and b is $ab \sin \theta$, and the phase difference of the wave trains at q (or Q) is $\frac{2\pi}{\lambda} ab \sin \theta$. Now $PQ = f \sin \theta = d$. Therefore, the phase difference between the wave trains is $\frac{2\pi}{\lambda} ab \frac{PQ}{f}$ i.e., it is proportional to the distance of Q from P.

Consider the vectors representing disturbances from successive elements as short rods hinged to each other at the ends (see Figure IV.). Then the line joining the ends of the composite rod will be the vector representing the resultant effect of all the elements. At P the waves are all in the same phase, the jointed rod or chain lies stretched out in a straight line (Figure IV. 1), and the resultant is the arithmetic sum of the components. At Q, from what has been said above, wave trains from adjacent elements will have a phase difference of $\frac{2\pi}{\lambda} ab \frac{d}{f} = d\alpha$ say, i.e., each section of the chain will make an angle of $d\alpha$ with the one next to it. Obviously,

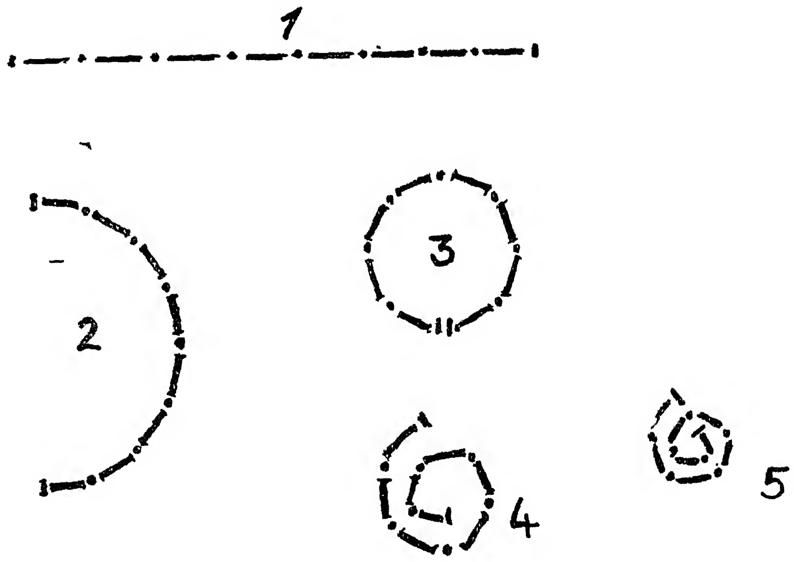


Figure IV

if there are n elements, the angle between the end vectors will be $\frac{2\pi n}{\lambda} ab \frac{d}{f} = n d\alpha = \alpha$ and as n ab = e = the width of the slit $\alpha = \frac{2\pi e}{\lambda} \frac{d}{f}$. Figure IV., 1, 2, 3, 4, and 5, show the chain of vectors for $\alpha = o, \pi, 2\pi, 3\pi, 4\pi$. Remembering that the resultant is the line joining the ends of the chain, it is easy to see that the visibility curve must have the general form found for it in section 3, Figure II. It must not be forgotten that the intensity of the illumination is proportional to the square of the amplitude of the wave, while the vector represents the amplitude. It is evident from a consideration of Figure IV. that the first minimum of the curve will occur when $\alpha = 2\pi$ which gives as found experimentally $d = \frac{f\lambda}{e}$ or $e \sin\theta = \lambda$. A more complete theory (see Schuster, Theory of Optics, p. 99 *et seq.*) shows that the expression giving the form of the visibility curve is $I = I_0 \left[\frac{\sin^2(\alpha/2)}{(\alpha/2)^2}\right]$ where I is the intensity, I_0, a constant and $\alpha = \frac{2\pi}{\lambda} e \sin\theta$.

SECTION 5. THE TWO LINE GRATING. POSITION OF SPECTRA FORMED BY A GRATING.

The slit C is widened till a second aperture of the grid begins to be uncovered. When a very narrow strip is uncovered the pattern of section 3 is still clearly seen in the eyepiece F, but it is furrowed by dark lines. A typical curve connecting illumination with distance from the crosswire is shown in Figure V. 1. On further widening the slit till the whole of the second aperture is uncovered, the dark bands deepen, and the pattern splits into bright strips, all but the centre one being coloured at the edges. The colours are dispersed more the further the strips are from the crosswire. These bright strips with coloured edges correspond to the spectra formed by gratings, and are, in fact, the spectra formed by a grating of two lines. Figure V. 2 shows the way in which V. 1 would develop on widening the slit. As will presently be shown, these spectra should be evenly spaced. Measure the distances of their centres from the centre of the central uncoloured strip with the micrometer eyepiece, and calculate the corresponding values of $\sin\theta$, θ having the same meaning as in the last section. It will be noticed that some gaps are double others, indicating that certain spectra are missing. This is due to the fact that they should appear where there is a minimum of the visibility curve, and where consequently there is no light available for their production. c Figure V. 2 represents such a case.

Draw and dimension curves similar to Figures V. 1 and V. 2 from your observations, and compare them with the dimensioned visibility curve you obtained as in section 3. Make a special note of any spectra that are missing. Compare the values you obtain for $\sin\theta$ for the centres of the spectra with $\frac{m\lambda}{l}$ where l is the distance between two successive apertures of the grid, m is an integer, and λ is a mean value for the wave length of white light, say 6×10^{-5} cms.

SECTION 6. THEORY OF SECTION 5.

The case taken for consideration is that observed when the two apertures are equal in width, i.e., when two complete apertures of the grid D are uncovered by the slit C. Consider the illumination at a point on the field of F corresponding to an angle of diffraction θ. Then from what has gone before, the illumination due to each slit separately is that

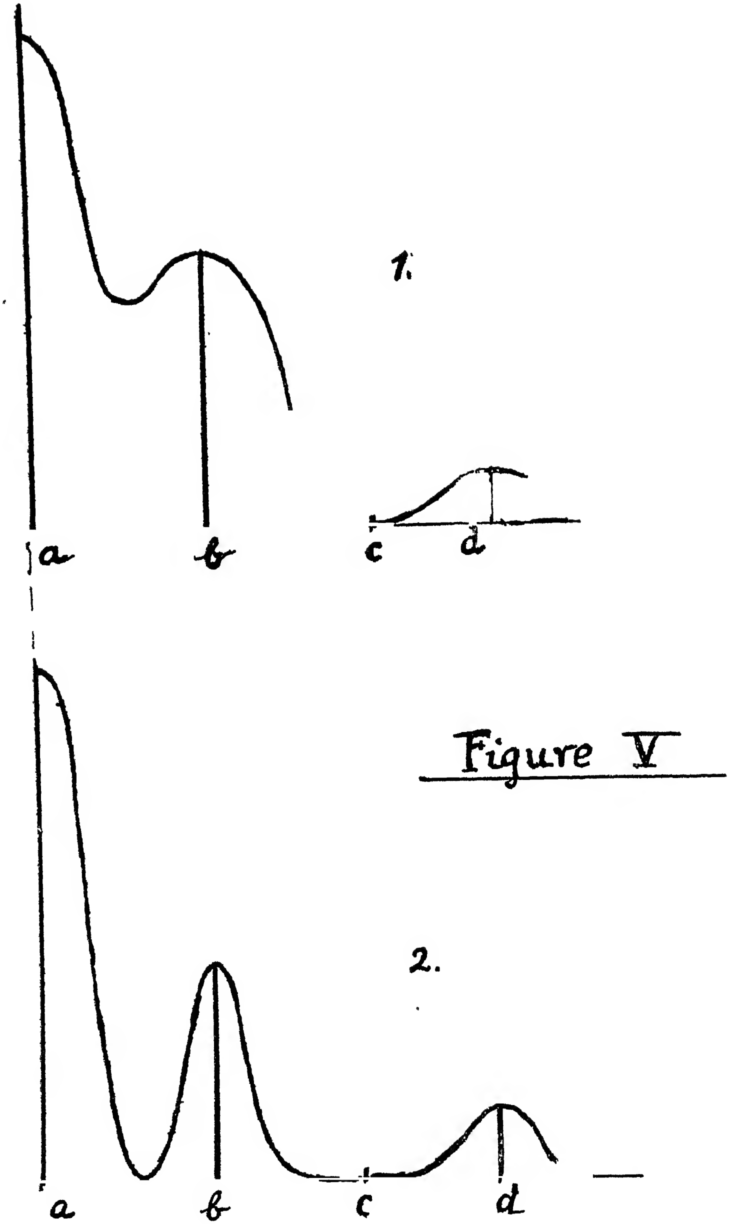


Figure V

given by the ordinate of the visibility curve, and these two beams will combine to produce illumination on the field.

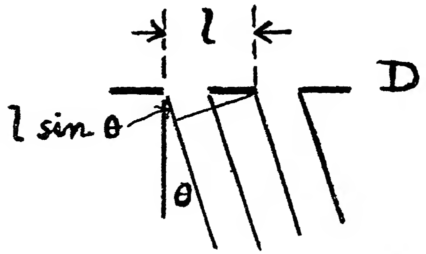


Figure VI

If the distance between corresponding points of the two apertures is l, the phase difference between the two beams is evidently $\frac{2\pi}{\lambda} l \sin\theta$ (see Figure VI.). Thus the two beams will completely interfere when $\frac{2\pi}{\lambda} l \sin\theta = \pi(2m-1)$ where m is an integer, i.e., where $\sin\theta = \frac{\lambda(2m-1)}{2l}$. The centres of the bright bands or spectra evidently come where $2\pi/\lambda\, l \sin\theta = 2m\pi$, i.e., where $\sin\theta = \frac{\lambda}{2l} 2m = \frac{m\lambda}{l}$. The spectra formed for m=1, 2, 3, etc., are called first, second, third, etc., order spectra. If the value of $\sin\theta = \frac{m\lambda}{l}$ is such that it coincides with the value for a minimum of the visibility curve, the spectrum will have zero intensity. Obviously in general, the intensity of the spectra will depend on the position they happen to occupy in the visibility curve, and this depends on the ratio of the pitch of the grating, l, to the width of the aperture, e.

The above discussion has been concerned with homogeneous light. In the case of white light, each colour forms its spectra in a different place, determined by the value of λ; hence the colour effects at the edges of the spectra.

SECTION 7. GRATING WITH MORE THAN TWO LINES. SECONDARY MAXIMA, ETC.

Widen the slit C till three apertures of D are opened and observe the appearance of the pattern in the field of F. Next uncover four apertures, then five and six. Finally, remove the slit C so that the whole of D is effective. D should con-

sist of about twenty apertures. As more slits are uncovered, it will be seen that the spectra, although their centres remain unchanged in position, become narrower and sharper, and the colours purer, and no longer confined to the edges. Also, in the dark regions between the spectra, now wider than before, secondary maxima appear. These are much narrower and fainter than the spectra themselves. It will be found that if N is the number of apertures exposed, the number of secondary maxima is $N-2$. They can readily be counted, for $N=3$, 4 and 5, but after that, become rather too faint and close together. On replacing the white light of the lamp by a sodium flame, it will be seen that the spectra are now quite narrow lines. This was, of course, indicated by the purity of the colours in the white light spectra.

Draw curves as in section 5, Figure V., and dimension them to show the positions of the centres of the spectra, the width of the dark bands separating them, and the positions of the secondary maxima. Verify that the positions of the spectra have not changed on increasing the number of apertures.

SECTION 8. THEORY OF SECTION 7.

For simplicity, the discussion will be confined in the first instance to illumination by homogeneous light. As in section 6, the visibility curves from the different apertures are superimposed, and the illumination at any point is limited by the ordinate of the visibility curve.

Consider first a grating with a large number, N, of lines. Let E be the total width of the grating. It may be looked on as an aperture of width E divided into N elements. Figure III, of section 4, represents this case as well as the case of a slit. The scale is, however, different. The whole discussion of section 4 will also be seen to hold, but instead of there being an infinite number of elements supplying light, there is a large finite number. E is much larger than e, and therefore the distances from P of corresponding parts of the diffraction pattern are much smaller, and instead of a broad central band, there will be a fairly narrow central line flanked by secondary maxima, the whole phenomenon being confined to a very narrow region near P. The first minimum occurs where $d = f\lambda/E$ or calling d/f (the very small angle which separates the maximum from the minimum) $d\theta$ it occurs where $d\theta = \frac{\lambda}{E}$

The essential difference between the two cases lies in the fact that on further increasing θ in the case of the grating, a point is reached where the resultant disturbance from one element differs from that from the one next it by exactly one wave length, i.e., the disturbances over q (Figure III.) are all in phase again. This is evidently where $l \sin \theta = \lambda$ (see Figure VI., section 6), and results in the first order spectrum. This can never occur for the slit, because the elements are infinitely close together, and $l=0$.

Refer to Figure IV., section 4, and consider the illumination at a point Q, as represented by the distance between the ends of the jointed rod or chain. As Q moves away from P, the chain passes through the stages 1, 2, 3, 4, and 5, and then continues coiling up on itself, the successive maxima becoming smaller and smaller. In the case of the grating, there comes a point where one section is turned back completely over the one next it, and a further rotation of the sections begins to uncoil the chain once more, the uncoiling continuing till one section has turned through 360 degrees relatively to the one next it, and the chain is again stretched straight out. It is here that the first order spectrum is found. In the case of the slit the sections being infinitesimal, the chain continues to coil up for ever, degenerating to a point when Q reaches infinity.

The above shows the reason for the existence of the spectra and the secondary maxima near the central line, but a little further consideration is needed to extend the discussion to the region in the neighbourhood of the spectra, and to find the position of the first minimum associated with a spectral line.

Referring to Figure VII., p is a wave front of the beam of rays which goes to form the central maximum of a spectrum, and q is the plane normal to the bundle which is united at the first minimum flanking the spectral line. Then the disturbances at C on both p and q are in the same phase, and the disturbances at C and B are in the same phase. Therefore, the phase difference between extreme rays of q is the same as the phase difference between B and D which is evidently $\frac{2\pi}{\lambda}[E \sin(\theta + d\theta) - E \sin \theta]$ $d\theta$ is very small. Identifying $\cos d\theta$ with 1 and $\sin d\theta$ with $d\theta$, this expression becomes $\frac{2\pi}{\lambda} E \cos \theta \, d\theta$. From section 4, Figure IV., the first minimum occurs when the phase difference between extreme rays of q is 2π, i.e., when $\frac{2\pi}{\lambda} E \cos \theta \, d\theta = 2\pi$ or when $d\theta = \frac{\lambda}{E \cos \theta}$.

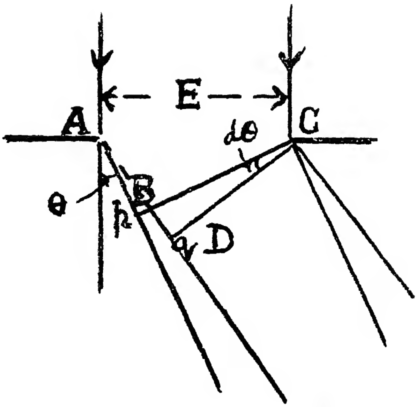


Figure VII

SECTION 9. COMPARISON OF THE EXPERIMENTAL RESULTS OF SECTION 7 WITH THOSE FOUND THEORETICALLY IN SECTION 8.

Using methods similar to those of section 4, and diagrams of the nature of Figure IV., find the number of secondary maxima that should appear between spectra given by gratings of 3, 4, and 5 lines. Roughly estimate their positions with respect to the spectra, and compare your results with those obtained experimentally in section 7.

SECTION 10. APPLICATION OF THE FOREGOING TO THE CASE OF THE ORDINARY TRANSMISSION AND REFLECTION GRATINGS.

The plane transmission grating consists of a transparent surface closely ruled with lines; 15,000 lines to the inch is an average spacing. In such a case, a transparent aperture will have a width of roughly 10^{-4} cms. The light from these apertures passes through a lens, and is focussed, all the individual visibility curves being superimposed. The angle through which the central maximum of the visibility curve extends on one side of the centre is given by $\sin\theta = \frac{\lambda}{e}$ (see sections 3 and 4). Here therefore $\sin\theta = (6\times10^{-5})/(1\times10^{-4})$, i.e., it extends over more than 30 degrees on either side of the direction of the incident light. The form of the curve

will not be exactly that deduced for smaller angles owing to the influence of obliquity, but the error introduced will not be large.

The spectra will appear at positions given by $\sin\theta=\frac{m\lambda}{l}$ (section 6), or if $\frac{N}{E}$ is the number of lines per cm. $\sin\theta=\frac{mN\lambda}{E}$ and their intensities will be as the ordinates of the visibility curve for corresponding values of θ.

The resolving power of a grating is defined as the reciprocal of the fraction of a wave length that separates two spectral lines which the grating can just exhibit as distinct, that is, if the lines have wave lengths λ and $\lambda + d\lambda$ the resolving power is $\frac{\lambda}{d\lambda}$. Experience indicates that if the maximum of one line falls on the first minimum of a line adjacent to it, the two lines can just be recognised as distinct. This, therefore, is taken as the criterion of resolution. Let two lines that a grating just resolves have wave lengths λ and $\lambda + d\lambda$. Then as $\sin\theta=\frac{mN\lambda}{E}$ (section 6) $\cos\theta\, d\theta=\frac{mN\,d\lambda}{E}$, and $d\theta$, the angle by which they are separated is $mN\,d\lambda/E\cos\theta$. Now the angle between the maximum of a line and its first minimum is $d\theta=\frac{\lambda}{E\cos\theta}$ (section 8). Then, as the two lines under consideration are just resolved, these two values of $d\theta$ must be equal, and $\frac{\lambda}{E\cos\theta}=\frac{mN\,d\lambda}{E\cos\theta}$ or $\frac{\lambda}{d\lambda}=mN$, i.e., the resolving power is the product of the order of the spectrum, and the total number of lines in the grating.

The foregoing discussion applies equally well to reflection gratings, and with slight modifications to the case of oblique illumination.

References.

Baly, Spectroscopy, Chap. VI.
Houston, Treatise on Light, p. 171 to p. 180.

Questions.

In a certain transmission grating the transparent spaces are the same width as the opaque spaces. Where on the visibility curve do the second and third order spectra lie?

Why cannot a two line grating resolve two spectral lines for which $\frac{\lambda}{d\lambda}$ is less than 6, although the expression obtained above would give 6 as the resolving power in its third order spectrum?

SECTION 11. APPLICATION TO THE ECHELON.

In this instrument some twenty plates of optically plane parallel slabs of glass, all accurately of the same thickness (about 1 cm.), are piled above one another, each one overlapping the one beneath it by about a millimetre. Light is passed normally through the pile, emerging from the overlapping ledges, which behave as the clear spaces of a grating, the beam coming from one ledge being retarded many thousands of wave lengths behind that from the ledge next it, owing to its passage through a greater thickness of glass. The spectra observed are thus of about the ten thousandth order.

The following brief discussion should be supplemented by reading. Treatments will be found in Schuster, Theory of Optics, p. 116; Baly, Spectroscopy, p. 190; Wood, Physical Optics, p. 274; and in other text books.

Figure VIII. shows two plates of an echelon. HL is a wave front for wave length λ in the m th order.

The Visibility Curve.—The width of the slit is about 1 mm. Thus (sections 3 and 4) the breadth of the central maximum of the visibility curve is given by 2θ where $\sin\theta = \lambda/e = \frac{6\times10^{-5}}{1\times10^{-1}}$ Therefore $2\theta =$ about 4 minutes. Outside this narrow range the spectra have not sufficient intensity to be observed, consequently the echelon is only useful for examining the fine structure of a spectral line or determining the separation of two lines very close together.

Separation of the Orders.—Let HK (Figure VIII.) be a wave front for wave length λ in the $m+1$ th order, e is about 1 mm. Therefore, $d\theta = LK/HL = \lambda/e =$ the angle between the two orders, is about $\frac{6\times10^{-5}}{\cdot1}$ i.e., is half the breadth of the central maximum of the visibility curve. The result is that there are in general two orders of every wave length in view in the field, and that the different lines are piled on one another in an inextricable jumble. It is, there-

fore, necessary to use the echelon in conjunction with an ordinary spectrometer or other device for selecting a narrow range of wave length.

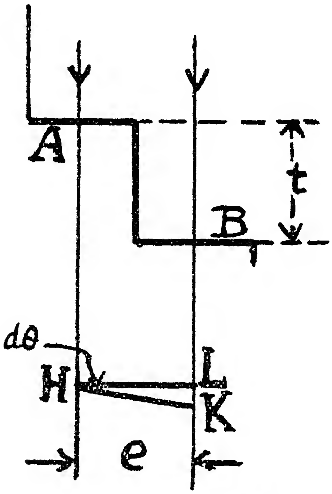


Figure VIII

Dispersion.—Let HK (Figure VIII.) be a wave front of wave length $\lambda + d\lambda$ of the m th order. From general considerations, it is obvious that the dispersion will be large, for if the refractive index of glass were a constant, LK would equal $m\, d\lambda$ [the ray BL would have an optical path $m\lambda$ and the ray BK a path $m(\lambda + d\lambda)$ longer than the ray AH], and thus with m large $d\theta$ must be relatively large. Actually the conditions are complicated by the fact that μ is a function of λ, μ being the refractive index of glass. It can very easily be shown, however (see references above), that the dispersion $d\theta/d\lambda = \frac{m - t\, d\mu/d\lambda}{e}$

Resolving Power.—Evidently to find the angle, $d\theta$, between the maximum of a spectral line and its first minimum, the discussion of section 8 holds without alteration, but with the restriction that θ is always very small, and therefore that $\cos\theta = 1$, very nearly. Therefore, $d\theta = \frac{\lambda}{E\cos\theta} = \frac{\lambda}{E}$

This is also the angle between the maximum of the λ line and the maximum of one of wave length $\lambda + d\lambda$ which is just resolved from it (see section 10), and this is given by the expression for the dispersion obtained in the last paragraph. Equating these two values of $d\theta$, $\frac{m\,d\lambda - t\,d\mu}{e} = \frac{\lambda}{E}$ and $E = Ne$ where N is the number of apertures. Therefore, $\frac{\lambda}{d\lambda} = N\left(m - \frac{d\mu}{d\lambda}\,t\right)$ Now $t\,d\mu/d\lambda$ is almost always less than .1 of m. Thus the resolving power is given very nearly by Nm, the same expression that holds for the ruled grating.

A NOTE ON THE KING ISLAND EMU.

By H. H. Scott,

Curator of the Launceston Museum.

(Read 8th October, 1923.)

The present note is to be regarded as being strictly additional to the published data of Spencer and Kershaw (1910). To recapitulate, it may be said that the authors quoted describe *Dromæus minor* in the following terms:—"Size varying considerably, but always smaller than that of "*D. novæ-hollandiæ;* not exceeding that of *D. peroni,* but of "more robust build. Tibio-tarsus rarely exceeding 330 mm., "most usually from 270-320 mm., in greatest length. Tarso-"metatarsus rarely exceeding 280 mm., most usually from "220-280 mm. in greatest length. Frontal region of skull "dome-shaped. Length of skull from frontal suture to "occiput not, or only slightly, exceeding 60 mm. Greatest "width of the skull not, or only slightly, exceeding 55 mm. "Habitat: King Island, Bass Strait. Now extinct." The range of measurements here given is wide, and it must be noticed that the exact ratio between the tibio-tarsus and tarso-metatarsus of any single bird is not stated. As a matter of fact, I happen to know that the material Spencer and Kershaw worked upon did not contain any three leg-bones that were beyond all question associates—neither did they hold any two that they could be certain were parts of a single bird. In these circumstances the notes I am here putting upon record should be welcome ones, as they detail the osteology of various bones, found buried in actual position, and beyond all doubt parts of a single individual Emu.

FEMUR.

The total length of the femur is 189 mm., the right being here taken, as it is a shade longer than the left. Both bones are in good order, and could not have exceeded 190 mm. at any time. The proximal width is 48 mm., and the distal 55 mm. It is of interest to note that Spencer and Kershaw place their maximum femur at a total length of 186 mm. We are, therefore, in possession of a maximum test bone upon their scale—a most fortunate circumstance, as it enables us, by a process of comparative ratios, to get a fair idea of the total height of a fully adult and apparently well-developed King Island Emu.

THE TIBIO-TARSUS.

The tibio-tarsus of our bird is only 285 mm. long, with a proximal width of 58 mm., and a distal width of 34 mm. Now, this agrees with number 25 of Spencer and Kershaw's list, whereas the femur practically agreed with no one! Obviously, therefore, either a maximum femur of this King Island Emu has not yet been found, or the ratio of the tibio-tarsus to femur was not constant, and that suggests sub-races, since the actual variation between specimens one and twenty-five is 109 mm.—far too much for sex variation. The actual maximum specimen of the published list is the property of the Launceston Museum (it was lent for descriptive purposes), and is therefore available to me at the present time. This tibio-tarsus has a proximal width of 73 mm., and therefore must have carried a heavier femur, since this is 15 mm. wider than our associate of the femur detailed above. It is not fair to claim the whole of this 15 mm., since the hamular process of the larger specimen is very robust; but at least 10 mm. of articular increase may be fairly assumed to have existed.

TARSO-METATARSI.

Both tarso-metatarsi are present, and, as obtains in the case of the other associates, they are in beautiful order. The greatest length is 237 mm. This falls into Spencer and Kershaw's list at about folio No. 25, and therefore agrees exactly with the tibio-tarsal position. The proximal width is 39 mm., and the distal width, 42 mm.

From these comparisons we are led to infer that our lists of tibio-tarsi and tarso-metatarsi of King Island Emus are more complete than that of the femora, but that, upon the whole, our conceptions of the actual size of the birds are fairly accurate. Spencer and Kershaw's remarks, quoted above, respecting variation in size, are accentuated by these notes; indeed, it is rather hard to account for all the variations among adult specimens by individual and sex-variation alone; and, unless we call in insular environment as a potent factor, we are without a solution of the problem.

THE EXTINCT TASMANIAN EMU.

Of the extinct Tasmanian Emu I have to record the finding of a tibio-tarsus, which was recovered from the Pleistocene swamp at Irish Town, N.W. Tasmania, during some draining operations carried out in 1920. Our

Museum is indebted to Mr. Willes, of this city, and to the finder of the bone—Mr. E. H. Fenton—for this interesting specimen, which, from its long immersion in the swamp, must be, beyond all doubt, the leg-bone of a Tasmanian Emu. Unfortunately, the bone is broken at its proximal end, the shaft terminating 44 mm. below the femoral articular platform. If the amount named be allowed for, it exactly agrees with a second similar-sized bone to be dealt with presently. If allowance is made for the cnemial crest, 75 mm., instead of 40 mm., should be added to the present length. Put into tabular form, we get:—

Total length of the imperfect bone	371 mm.
For restoration to articular platform allow 40 mm., or to the top of the cnemial crest, allow another 35 mm.—total	75 mm.
Total for the greatest length of the bone	446 mm.

This tibial length (446 mm.) gives the Tasmanian Emu exactly the maximum mainland tibial length (as cited by Spencer and Kershaw upon page 21 of their brochure), but, as I shall show presently, the variation incidental to the insular species was more tarso-metatarsal than tibio-tarsal. The point to be noted here is that the bone is beyond all question of Tasmanian origin, since its inclusion into the peaty matrix of the swamp was certainly at a much earlier date than that at which any mainland Emus were imported into Tasmania, and therefore it stands as the earliest known specimen of a Tasmanian tibio-tarsal shaft.

I have next to mention the finding of the leg of a Tasmanian Emu, recorded by Ronald Gunn (1852, p. 170), who says:—"A leg of a Tasmanian Emu is now in my possession, "and as far as I can judge from it, as a very imperfect "specimen, there are differences in the arrangement and "size of the scutes, which may justify the separation of the "Tasmanian Emu from that of New Holland." A footnote supplied by the secretary of the Royal Society—Mr. J. Milligan—says:—"Captain Hepburn, of St. Paul's Plains, "possesses a breed of Tasmanian Emus, which he succeeded "in rearing from eggs found many years ago upon the "high, heathy land in his vicinity. Mr. J. Hepburn informs "me that the booming noise is not peculiar to the female, and "that the male bird does, though not frequently, make the

"same sound. The Tasmanian Emus share the toils of "incubation between the sexes, but upon the mother devolves "the care of bringing up the young brood, to which the "male parent, for the most part, displays an unnatural and "most bitter antipathy." After resting in the cellar of Newstead House for some 70 years, this Emu's leg has now come to light again, and is upon the table before me as I write. Gunn's statement that the scutes make a departure from those of the mainland Emu's leg is quite correct, when comparison is made between the dried skin of his specimen and that of a mounted Australian Emu shown in our case. It will be noted, however, that Gunn makes the reservation, "so "far as I can judge from a very imperfect specimen," meaning, obviously, as the specimen still shows, that the outer cuticle has peeled off the scutes, and, in this condition, they appear far less developed than obtains with the Australian Emu. That the scutes should vary upon the tarso-metatarsus, during the creation of a species, and, indeed, that the bone itself should vary more than the other bones of the leg, is not unexpected, since the tarso-metatarsus is a later evolution than either the femur or tibia, and is therefore more plastic, and accordingly responsive to external conditions. Just how much the scutes varied, cannot be accurately stated to-day, any more than it could by an examination of the specimen 70 years ago, so we are restricted to Gunn's statement in his own terms, which personally I am inclined to accept; and I conclude that the cuticle and its under layers may very well, during life, have manifested differences that added to the several specific characters of size and colour. As this leg is beyond all question that of a Tasmanian bird, it supplies us with the following comparison:—

Tibio-tarsus	446 mm.
Tarso-metatarsus	377 mm.

The femur is not present, and may never have been in Gunn's possession, but the central and external toes and part of the internal toe, are still in the skin—the bones being those of a right leg.

When the tibio-tarsus from Newstead House is placed upon the measuring plate, side by side with the sub-fossil bone recovered from the Irish Town swamp—the one being a right, and the other a left—the two bones so exactly agree in every respect that, except for locality and age, they might be selected as associates.

There are thus available to students two tibio-tarsi, one tarso-metatarsus, and a nearly complete foot of a Tasmanian Emu, which are beyond all question correctly named, and which cannot be derived from Australian Emus introduced into Tasmania.

Whatever the variations in colour, plumage, and dermal scuting may have been, it would appear that the tarso-metatarsus was relatively shorter in the Tasmanian, than in the mainland, form. In a specimen of *Dromæus novæ-hollandiæ,* with a tibial length of 446 mm., we should look for a tarso-metatarsus of 411 mm., instead of one of 377 mm., as in Gunn's specimen.

Much historical data have been published by G. M. Mathews in regard to both the Tasmanian and the King Island Emus; and as this work is commonly available, it need not be even quoted here.

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DESCRIPTION OF TWO UNDERGROUND FUNGI.

By L. Rodway, C.M.G.

(Read 8th October, 1923.)

Tasmania is peculiarly rich in underground fungi belonging to the family *Hymenogastraceæ*, and new members are constantly being found. I wish here to record two such plants. They both belong to the genus *Hydnangium*.

Hydnangium clelandi, *n.s.* Subglobose without a sterile base, 1-2 cm. diameter. Peridium pale yellow, tough, about one millimetre thick, readily separating. Gleba compact, dark brown, often with a greenish tinge; spore cavities large, isodiametric, as in *H. tasmanicum*, separated by thin tramal plates. Spores pale yellow, globose, smooth, or becoming slightly rough when old, 21 μ. diameter, exospore very thick. It differs from *H. archeri* in the absence of a sterile base and smooth spores.

Underground on hills about Hobart. Rare.

Named in recognition of the work done in mycology by Dr. Cleland of the Adelaide University.

Hydnangium mc'alpinei, *n.s.* Irregularly globose, without a sterile base, very dark, 1.5 cm. Peridium thin, tough. Tramal plates very thin, gleba dense, nearly black. Spores very dark brown, globose, 9-10 μ., rough, with small warts.

Very similar to *H. tasmanicum*, but the spores much darker, and not echinulate.

South Australia.

Named in honour of D. McAlpine, of Melbourne.

R. M. JOHNSTON MEMORIAL LECTURE.

GEOLOGICAL EVIDENCE OF THE ANTIQUITY OF MAN IN THE COMMONWEALTH, WITH SPECIAL REFERENCE TO THE TASMANIAN ABORIGINES.

By

PROFESSOR SIR T. W. EDGEWORTH DAVID, K.B.E., C.M.G., F.R.S., B.A., F.G.S.

Plates VIII.-XI.

(Read 8th October, 1923.)

CONTENTS.

PART I.

BRIEF SUMMARY OF THE LIFE AND CHARACTER OF R. M. JOHNSTON.

The great honour and privilege has been conferred upon me by the Fellows of the Royal Society of Tasmania of inviting me to deliver the first of the Memorial Lectures to a truly great man, one who always gave of his best, and whose whole life was one of loving and faithful service, the late Robert Mackenzie Johnston. From my heart I thank you for this privilege.

Already a grateful country has published a fine work in "The R. M. Johnston Memorial Volume," embodying his chief papers and pamphlets and giving a summary of his biography, with a foreword from one who perhaps knew him best, the Hon. Sir Elliott Lewis. The Royal Society of Tasmania in its volume for 1918 has also given a short biography and a complete list of his published papers. Under these circumstances, I do not propose to more than very briefly touch upon his life work, but will review briefly some recent geological researches inspired largely and to a great extent built on the foundation which Johnston so well and truly laid.

Though one shrinks from treading on such holy ground as that of the life of a vanished friend, one is nevertheless drawn to do so by the strength of one's love for him, for in the simple phrase of the country of his birth, he was "a lovely man."

Born in 1845 at a little fishing village in the Black Isle, on the shore of the Moray Firth in Scotland, he died in Hobart in 1918 at the age of 73 years. His father had a small croft, on which he owned a humble cottage.

Young Johnston was educated at the village school, and derived much inspiration from the works of the famous stone-mason geologist, Hugh Miller, who lived in the neighbouring town of Cromarty. His early taste for geology may be traced to this source. He left school very young, and for two years was herd laddie and harvest hand on a neighbouring farm. In spite of hard work he found time for some reading, and the ambition grew strong within him to see something of the great world. When only a laddie of 14 years of age he showed the great strength of his character in breaking from all his surroundings. In the long

run this break brought him to Hobart. It is a pathetic story. One is tempted here to parody Kipling:—

"How far is Hobart City from a Scottish lad at play!
What makes you want to wander there with all the world between?
Oh mother, call your son again, or else he'll run away."

But young Robert had no mother to call him back. She had died some years before, and so he ran away. How terrible must have been the mental strain and struggle for one so young and so strongly swayed by his affections to break away from his father and sister, and seek his fortunes in the great world beyond his ken!

By the sweat of his brow he earned his daily bread at Edinburgh, but still found time to read. He read poetry, science, fiction, and philosophy. Later he left Edinburgh to do manual work on a railway in the North of Scotland, interesting himself in the geological structure of the country as revealed in the cuttings. His good work won him the position of a ticket clerk, and later he became clerk at a Railway Goods Department, Glasgow. In 1870, at 25 years of age, he once more showed his enterprise, ambition, and tenacity of purpose by selling all his books, and most other belongings, and emigrating to Victoria. He was engaged as a clerk at Colac. While here, when the first railway line in Tasmania—that from Launceston to Deloraine—had been opened, he received the appointment of clerk in charge of the accountant's department, and soon afterwards was promoted to chief clerk in the Auditor-General's Office. In 1881 he was appointed to the newly-created office of Government Statistician and Registrar-General for Tasmania, a position which he held for 37 years until the time of his death.

Others can speak with authority on the great value of his numerous annual volumes of Tasmanian statistics, of the very important work he accomplished in unifying methods of presenting statistics, methods followed later by statisticians in various parts of Australia, on his contributions to economic questions relating to Labour and Capital, to the framing of the *per capita* scheme for the equitable distribution among the States of the Commonwealth (that was being initiated) of the surplus revenues derived from the collection of Customs and excise duties, and the successful advocacy of proportional representation. One who can speak with authority has already spoken of this already in terms of high praise that carry weight, Sir Elliott Lewis, and *laudari a laudatis viris summa laus.*

The above was his chief life work. It is specially his hobbies that claim the attention of his brother scientists.

When at Launceston he became the friend of Mr. Gunn after whom not a few Tasmanian plants have been named. and from him derived a taste for botany. Later he contributed five papers on the flora of Tasmania.

His extraordinary versatility and energy are shown by the fact that he also contributed eight papers on mollusca, sixteen upon fishes, and no less than 56 papers on geological subjects.

He was Royal Commissioner on Fisheries, and I am informed by no less an authority than Mr. C. Hedley, F.L.S., of the Australian Museum, Sydney, that Johnston's work on the fishes was of great value, and, particularly in view of the many limitations in those early days, was most meritorious. The great work which he published in 1888, "The Geology of Tasmania," with an account of the minerals and rocks of Tasmania, has laid a splendid foundation on which future generations may build, and his geological map of Tasmania is a masterpiece. There is, of course, much to be added to it, but little to alter in the main features. But in profiting by the wealth of information in his classic books and papers, one must not lose sight of the tremendous physical effort, hardship, and privation which he, with his stalwart comrades, endured in their quest of the unknown, a quest fraught with difficulties which might well have appalled all but the bravest of the brave. We know that in 1874, in company with the late J. A. Scott, W. C. Piguenit, Lieutenant Burgess, and two others, R. M. Johnston spent six weeks (all of the party laden with knapsacks weighing from 60 to 70lb.) in exploring the whole of the south-western highlands lying between the mouth of the Huon and Macquarie Harbour, and in making collections and observations on the geology and botany of that region.

In 1879 he formed one of a similar party in exploring the northern region of the western highlands, including Gad's Hill, Middlesex Plains, Vale of Belvoir, Valentine's Peak, Mount Bischoff, the headwaters of the Mackintosh Valley, and other tributaries of the Pieman and Arthur Rivers.

Next, in the year 1887, in company with his friend, the late C. P. Sprent, Deputy Surveyor-General, and five others, he traversed on foot and examined the whole of the region lying near to the route across the island by way of the

Ouse, Bronte, Lake St. Clair, Mount King William I., Mount Arrowsmith, Collingwood Valley, King River, Mount Lyell, Queen River, and Macquarie Harbour, thence northward across the Henty, Mount Heemskirk, Corinna, Whyte and Heazlewood Rivers, Magnet Range, and Mount Bischoff, to Emu Bay on the North-West Coast. Only those who have experienced them can realise what terrible barriers to progress are the native scrubs, the "horizontal," the *Bauera,* and the myrtle scrubs, not to mention the dense masses of fern, rotten sassafras, logs, etc., and the swiftly rushing and swollen streams to be crossed, by the slow and tedious process of felling trees to span the rivers. All this would be most trying to the most vigorous and unencumbered of men, but how Johnston and his colleagues and their hardy predecessors wet, cold, weary, and half famished, fought their way through these almost insurmountable obstacles, each with his 60 to 70lb. weight of pack, involved efforts almost superhuman.

We who have entered into their labours and follow now so easily and swiftly in train or car where they so slowly and painfully, but so surely, blazed the trail, must not forget the hardy heroic pioneers who marched ahead of the army of occupation. Who were these heroes? Men such as he who was such an early inspiration to science in this country, the heroic sailor soul, Sir John Franklin, and it should not be forgotten that in his desperate march through scrub and jungle to Port Davey Lady Franklin went with him and shared his hardships; men such as Charles Gould, C. P. Sprent, J. A. Scott, W. C. Piguenit, Lieutenant Burgess, and many another, and last, and not least, the man we to-night specially delight to honour, R. M. Johnston.

And while we honour these leaders among men, let us not forget the pioneer work of the rank and file, that goodly fellowship of prospectors and pathfinders, many of whom perished lonely and unsung. Surely not the least honour is due to the memory of these unknown warriors.

The spirit of these men lives yet, in young explorers of Tasmania to-day, as testified by the recent fine journeys made under the leadership of Major L. F. Giblin and A. V. Giblin, which have led to the conquest of Mount Anne. As one who may be permitted to claim to have attempted some pioneering work in another field, I would offer here a humble and heartfelt tribute to the pioneers of Tasmania, and foremost among them to my old comrade, R. M. Johnston.

PART II.

GEOLOGICAL EVIDENCE OF THE ANTIQUITY OF MAN IN THE COMMONWEALTH, WITH SPECIAL REFERENCE TO THE TASMANIAN ABORIGINES.

One now passes to notes on the special research "Evi- "dence of the Antiquity of Man in the Commonwealth, with "special reference to the Tasmanian aborigines."

This subject would not seem inappropriate to this memorial lecture, as Johnston was no mean authority on the Tasmanian aborigines and their implements, and, moreover, their ancient history, as will presently appear, was intimately linked up with phases of the great ice age through which Tasmania has passed many thousands of years ago, and evidence of the former presence of glaciers and ice sheets in Tasmania was a favourite subject of research for R. M. Johnston. One of his chief scientific papers is wholly devoted to this subject.

Before proceeding to consider the age of the first coming of man into Tasmania and Australia, we must briefly review some time scale, to which we can refer the evidence, a scale which has been made after much toil of many workers in the Northern Hemisphere.

This scale depends on phases of what is known as the Pleistocene Ice age. It is now generally recognised that there were four glaciations, separated from one another by three mild inter-glacial phases.

1. Time Scale Supplied by Pleistocene Glacial Epochs.

a. In the Northern Hemisphere. (24)

These four glacial phases, with their inter-glacial phases, were approximately as follows:—

Post-glacial Time, about 7,000 years, that is, about 5,000 B.C., to present.

Würm or Wisconsin Ice Age, 5,000 B.C. to 15,000 B.C. (possibly 50,000 B.C.).

Dürntenian or Sangamon, mild epoch, 15,000 B.C. to 60,000 B.C.

Riss or Illinoian Glaciation, 60,000 B.C. to 80,000 B.C. (possibly 150,000 to 180,000 B.C.).

Helvetian, or Yarmouth, or Tyrolian, mild epoch, 80,000 B.C. to 250,000 B.C. (possibly 180,000 to 350,000 B.C.).

The Mindel or Kansan Glaciation, 250,000 B.C. to 280,000 B.C. (possibly 360,000 to 400,000 B.C.).

Norfolkian, Aftonian, or Cromer, mild epoch, 280,000 B.C. to 350,000 B.C. (possibly 400,000 to 470,000 B.C.).

Günz Glaciation, 350,000 B.C. to 380,000 B.C. (possibly 470,000 to 500,000 B.C.).

The estimates for the last mentioned phases of glaciation, such as the Günz and the Mindel, are necessarily only very approximate. The age of the Günz glaciation, for example, may have been as far back as fully 500,000 years ago.

b. In Tasmania.

In Tasmania there have been many workers who have recorded evidences of the great Pleistocene glaciation of this island, notably R. M. Johnston, C. Gould, C. P. Sprent, T. B. Moore, M. E. J. Dunn, A. Montgomery, Graham Officer, Lewis Balfour, E. G. Hogg, W. H. Twelvetrees, L. K. Ward, Professor J. W. Gregory, Dr. F. Noetling, Dr. W. N. Benson, Professor T. Griffith Taylor, Dr. Loftus Hills, Mr. Mackintosh Reid, and Mr. Arndell Lewis. Professor J. W. Gregory has also given a special account of the area near Queenstown and Mount Lyell, Q.J.G.S. He concludes that the glacier ice in the Linda Valley, near Gormanston, and near Queenstown, came down to within about 900 to 1,100 feet of sea level. Professor W. N. Benson has described in detail the Cradle Mountain area, and concludes his valuable paper with a full bibliography of Tasmanian Pleistocene glacial literature. (1) Professor Griffith Taylor and Mr. Arndell Lewis agree that there are evidences of at least two, if not three, glacial invasions of Tasmania during Pleistocene times. The earliest apparent one "was by far the most considerable, "and was followed by two later phases." This earlier glaciation developed an ice sheet, which actually came down to sea level at Port Davey, extended to below 1,000 feet above sea level, in the neighbourhood of Gormanston and Queenstown, and came down to within 100 feet or less of sea level between the mouth of the Henty River and the Eden Valley. Recent observations by Dr. Loftus Hills and the writer have fully confirmed Mr. T. B. Moore's statement as to the downward limit of the Pleistocene ice sheets, when at their maximum development, in that part of Tasmania. So extensive was this glaciation that fully a third of Tasmania was under a more or less continuous ice sheet, with points like Barn

Bluff, Cradle Mountain, Mt. Pelion, etc., showing as nunatakr. "Outwash apron gravels" deposited by the thaw waters of surface or subglacial streams now cover low-lying strips around Macquarie Harbour, and thence northwards to beyond the mouth of the Henty River. These outwash gravels are separated from one another by deposits of peaty sand and peat. They have previously been described as raised beaches, but the writer would point out that while there is evidence there, as in most parts of Tasmania and Australia, of a raised beach up to 15 feet above high water, accompanied by the presence of marine shells, no trace of post-Tertiary marine shells, as far as the writer is aware, has ever been found in Tasmania at a higher altitude than about 15 feet above high water. The great shingle terraces, on the other hand, in the neighbourhood of Kelly's Basin, Macquarie Harbour, and to the east of Strahan, attain altitudes of from 200 up to over 240 feet above sea level. Close to Strahan railway station the following section was measured by the writer at the lowest terrace there:—

1ft. 3in.	Peaty sand.
6in. to 9in.	Loose grey sand.
2ft. 0in.	Peaty sand. A few pebbles near the top.
2ft. 0in	Shingle with pebbles mostly 3 to 4 inches in diameter, resting on an eroded surface of peaty shale.
3ft. 0in.	Laminated hard peaty shale, emitting a slightly woody ring when struck.
33ft. 6in.	Mostly coarse shingle, pebbles from 1 inch up to 1 foot in diameter, oval and well rolled. In the lowest 5 to 6 feet of this bed there are numerous disrupted fragments of carbonaceous shale, belonging apparently to slightly older post-Tertiary or late Tertiary formation. These disrupted fragments are on a line of strong erosion.
18ft. 0in	Sandy clay, carbonaceous, passing almost into peat in places, but the top 5 feet is mostly sandy, weathering yellowish grey. This extends down to sea level.
Total 60ft. 3in.	

There are many hundreds of feet in thickness of soft sandstones and clays below the lowest bed of shingle, but they appear to be pre-glacial.

Mr. Arndell Lewis would ascribe such outwash gravels to the maximum Pleistocene ice-sheet of approximately Riss or Mindel age. Mr. Arndell Lewis appears tentatively to hold the view that the lowest evidence of glaciation in the Broad River Valley at National Park is of about the same age as the outwash gravels of Strahan. Such glaciation at National Park would be approximately at its lower limit about 2,000 feet above sea level, possibly as high as 2,400 feet.

Recently Dr. Loftus Hills has observed evidences of glaciation at Mount Victoria, between St. Helens and Scottsdale, at an altitude of about from 3,964 feet (which is given as the altitude of the summit) for several hundreds of feet downwards.

The question of Pleistocene glaciation and its age in this north-east part of Tasmania is of special importance in regard to a very important piece of evidence about to be detailed presently, by far the oldest as yet recorded on the subject of the antiquity of aboriginal man in Tasmania.

In this part of the island there are widespread sheets of shingle and gravel, with peaty beds intercalated, which have been worked extensively for stream tin between Herrick and Boobyalla. At the Pioneer Mine, to the north of Herrick, these strata attain a thickness of at least 80 feet; they are up to 68 feet in thickness at the Scotia Mine, one mile to the north-west of Gladstone. At the old Doone Mine, about a mile west of the Scotia, the drift was about 15 to 25 feet thick. The drift apparently dips below sea level towards the coast below Boobyalla. It appears to the writer that this old peaty granite sand drift, which the late W. H. Twelvetrees suggested tentatively (35) was raised beach material, is in reality, in view of later evidence now available, outwash apron material, analogous to that of Strahan. In this case it would have been formed by the thaw waters of the last great ice sheet, at newest the Würm ice sheet, dating back to about 17,000 years ago. If this supposition is correct, the deposit would have been laid down by extensive floods coming from the head of the Ringarooma Valley and its numerous tributaries, at a time when Mount Victoria was under ice and the lower spurs of the adjacent ranges supported extensive nevée fields.

An attempt has been made in the table given in the summary of this paper on pages 130, 131, to supply a provisional scheme to show the probable approximate relative ages of the evidences of the presence of early man in Tasmania and Australia. This table is very tentative, and the dates, of course, very approximately assigned, may be much in error, but it is believed, nevertheless, that they are a reasonable approximation. We may now proceed to consider the details with regard to the antiquity of man within the Commonwealth, commencing with Tasmania, and then passing on to Australia. No attempt is made to put forward any case for man having a geological antiquity in New Guinea. Evidence, in the writer's opinion, will be forthcoming later to prove that his first coming into New Guinea dates a long way back into the past.

2. Evidence of the Antiquity of Man.

A. In Tasmania.

i. Geological and Geographical.

   a. Occurrence of aboriginal chalcedonic flake in fluvio-glacial (?) compact drift at the Doone Mine, near Gladstone, North-East Tasmania.

   b. Occurrence of aboriginal chipped pebbles and stone cores at Regatta Point, on right bank of Tamar River, one mile north of Launceston. Numerous specimens of this type were found by the writer last February in the consolidated shingle of a slightly raised beach (3-4 feet above high water).

   c. Occurrence of very numerous aboriginal cherty flakes and other implements in what appears to be an old natural shore-line of the so-called Lake Leake, now an artificial reservoir, 15 miles east of Campbell Town.

ii. Antiquity deduced from distribution of implements.

   a. Wide area over which stone implements are found in Tasmania, and the vast number of such implements.

   b. The thickness and extent of the aboriginal kitchen middens.

iii. Cultural evidence.

   a. Palæolithic or Eolithic stage of culture of the Tasmanian aborigines.

b. Ignorance of making sea-going canoes. This implies that they must have crossed the Bass Strait area at a time when Tasmania was a peninsula of Australia.

iv. Anatomical evidence.

a. Alliance of Tasmanians to the primitive negrito races.
b. Archaic type of their dentition.
c. The Tasmanian a true *homo*, and probably newer than *Pithecanthropus* of Bengawan, Java, or *Eoanthropus dawsoni*, of Piltdown, Sussex.
d. Tasmanian aboriginal, though for long an inhabitant of a cool temperate climate like Tasmania, does not exhibit any tendency towards a whitening of his skin, which appears to have maintained throughout its original blackness.

v. Associated fauna.

a. In this respect the entire absence of the dingo from any human remains in Tasmania corroborates the evidence suggested by the Tasmanian aboriginals' ignorance of the art of making sea-going canoes, that he arrived in Tasmania by a land bridge before the dingo was imported into Australia by the early Australian aboriginal.
b. Evidence is not yet to hand that the Tasmanian aboriginal was contemporaneous with extinct animals such as the marsupial rhinoceros (*Nototherium mitchelli, N. tasmanicum,* etc.), and yet the peaty deposits of Mowbray Swamp, near Smithton, appear to belong to an age at least as new as the stream tin deposits of the Gladstone district, in which a human-worked flake has been found. Moreover, Messrs. H. H. Scott and Clive E. Lord describe the femur of the calf of a *Nototherium* from the above swamp which has been damaged by some sharp-cutting tooth or instrument, possibly either the carnassial tooth of a *Thylacoleo* or an aboriginal hache. (20)

We may now review these evidences in detail. In regard to i.a., the late Mr. W. H. Twelvetrees has described this occurrence (Roy. Soc. Tas. Papers and Proceedings,

1916, pp. 48-50, pl. 5). The flake is formed of chalcedony, which, after being struck off by a single blow, has been dressed on one side and retouched later on the same side so as to give a number of small saw-like teeth to the cutting edge, which was evidently used for smoothing down or sharpening spears. Mr. W. H. Twelvetrees submitted the flake, just after its discovery, to the late Mr. R. M. Johnston, who had an exceptionally wide experience in the matter of Tasmanian stone implements. Mr. Johnston was absolutely convinced at once, as indeed anyone must be with any knowledge of the subject, that the flake was of human workmanship. This flake is illustrated on Plate VIII.

It was found at the old Doone Mine, about three miles north-westerly from Gladstone, and under an overburden of about 10 feet of very firmly compacted drift. This drift was formed of granite sand, with a certain amount of interstitial clayey peat. Mr. Twelvetrees was of opinion that the whole deposit was of marine origin. In view of later sections and discoveries, the writer cannot entertain this view, and holds, as the result of a personal examination of the scene of the discovery, and of similar deposits in other parts of Tasmania, that the deposit is to be correlated, as regards origin, though younger in time, with the "out-wash "apron" deposits of Strahan, on the west coast of Tasmania. These consist of gravel with peaty sands, peaty clays, and peat, and lie on the seaward side of the great terminal moraine between Eden and the Henty River, which marks the maximum advance of the old Pleistocene ice-sheet in Tasmania as far as present evidence goes. Certainly the deposit at Gladstone is very wide spread, and at the Pioneer Mine, a few miles to the south, it is over 80 feet in thickness. Obviously, since the deposit was laid down, the Ringarooma River had deepened its channel by at least 60 feet, as shown on the section, Pl. IX. The river did not occupy its present channel, in Mr. Twelvetrees' opinion (in which the writer concurs), at the time when the drift was deposited at the Doone Mine.

The flake was found by Messrs. Richards and Murray at the time when Mr. Richards was using the hydraulic nozzle to wash away the overburden from above the tin gravel. The latter is there about 2½ to 4 feet thick. Mr. Richards had been requested by Mr. Twelvetrees, a day or two before, to be on the look out for possible traces of sea shells in the deposit. Richards's attention was attracted suddenly by the unusual object of this chipped flake, which

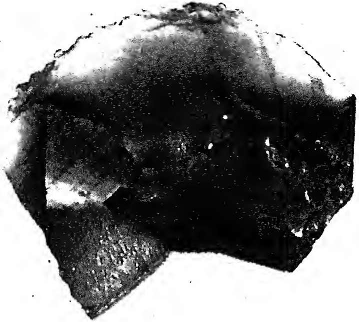


Fig. 1. Obverse (x 1½).

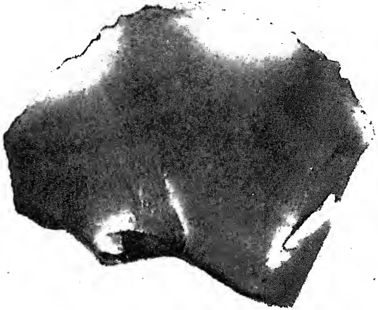


Fig. 2. Reverse (x 1½).

Figs. 1 and 2. Aboriginal chalcedonic flake, found *in situ* at 10ft. below the surface in consolidated fluvio-glacial (?) drift immediately overlying stream tin gravel, Doone Mine, 2½ miles N.W. of Gladstone, N.E. Tasmania.

he thought to be a shell, just exposed to view by the water jet. He immediately went forward, and picked it out of its matrix, to which it was slightly adherent. In doing so, a small piece fell off. This has not been preserved. He called to Mr. H. Harvey, the Government inspector of the Mount Cameron water race, who was close by in the mine at the time, and who informed the writer (last February) that, on hurrying to the spot, he carefully examined the site from which the flake had been picked by Mr. Richards, and distinctly recalled the fact that he noticed at the time of the discovery that there was a well marked impression in the old drift, into which the flake exactly fitted, and from which it had been lifted out by Mr. Richards.

Mr. Murray, a son of a late Government Geologist of Victoria, Reginald Murray, and a partner of Mr. Richards, quite confirms the account originally given by Mr. Richards to Mr. Twelvetrees, and also that now given by Mr. Harvey. They all agree that there is not the slightest possibility of the flake having fallen from above and having been driven by the water from the hydraulic nozzle into the compact drift. The extreme freshness of the chalcedony considered as a mineral specimen (that is, the remarkable absence of weathering) made the writer seriously consider at first the possibility of the flake having been artificially injected, in the manner indicated above, into the drift overlying the stream tin, but he is quite satisfied that some other explanation must be found for its extraordinarily fresh state of preservation. He thinks it is to be attributed to the interstitial peaty clay in the sand having stopped all water circulation and also prevented contact with the air, and so checked weathering. At the same time, the "retouching" on the edges of the flake suggests to him a more modern phase of artefact evolution than that indicated by the specimens about to be described, from a more recent deposit.

The following is a general section at the old Doone Mine southwards to the present channel of the Ringarooma River:—

Surface level, about 100 feet above sea.

6in.	Peaty humus covered with grass
6in.	Grey sand.
6in.	Peaty sand.
4in.	Grey sand.
10in.	Hard ochreous sandy silt.

6ft 0in.	Dark grey fine sandy silt, compact and dark grey, through peaty material. This rests on a slightly eroded surface.
4ft 0in.	Gritty, pebbly sand rock; the aboriginal chalcedonic flake occurred in this layer, immediately overlying the stream tin gravel below.
8ft. to 12ft. 0in. in places thinning to 3ft.	Gravelly consolidated drift, with stream tin and well rolled pebbles of quartz and slate from 1 inch to 3 inches in diameter, and sub-angular reef quartz up to 6 inches in diameter; pot-holes of shingle occur in places about 3 feet in depth. The lower part of this drift yields stream tin at the rate of from 1 to 1⅓lb. per cubic yard.
	Floor under stream-tin drift fine-grained, greenish felspathic quartzite; dips W. 18 deg. S. at 18 deg. The age of these sedimentary rocks is assumed to be Cambro-Silurian.

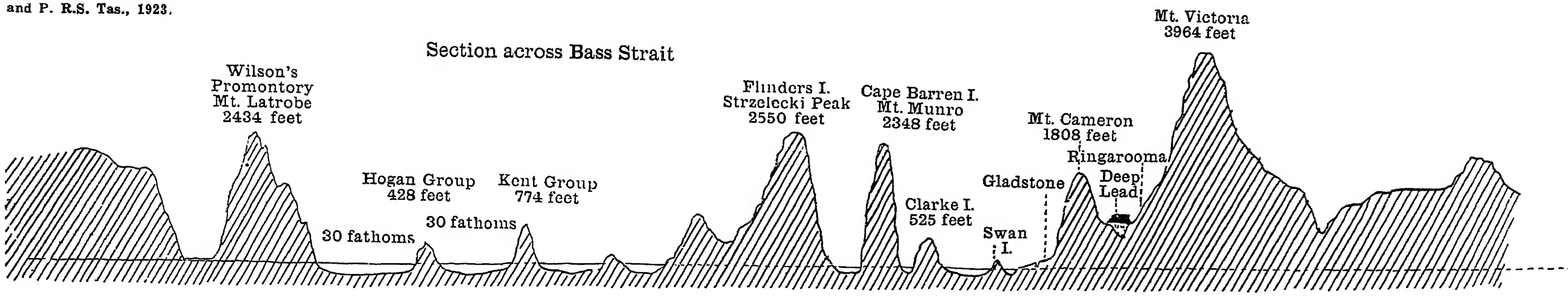
The undulating, but on the whole flattish, floor, on which the drift reposes, is just about 65 feet above the Ringarooma River and 85 feet above sea-level.

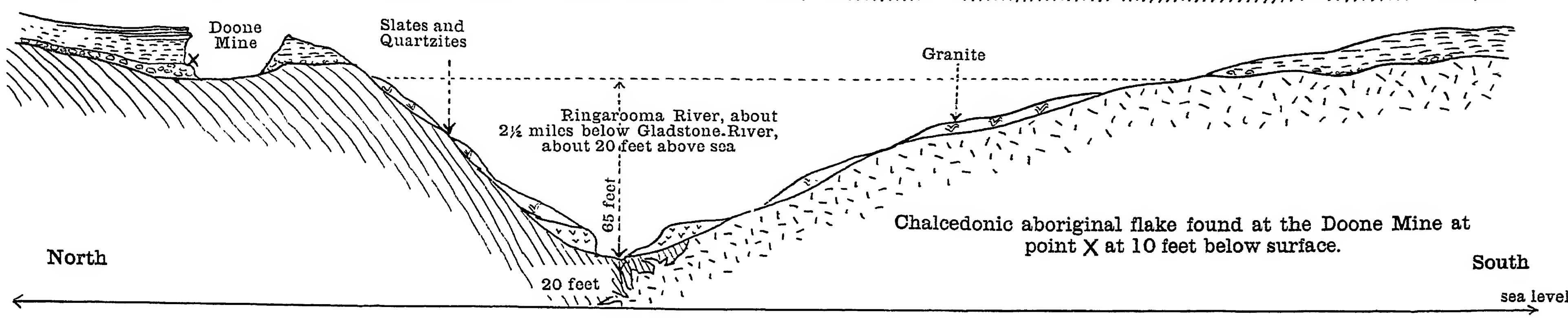
At the time these wide-spread gravels and sands were being deposited, the Ringarooma River could not have occupied its present channel, which is about a quarter of a mile to the south, and which has subsequently been deepened in hard rock (partly felspathic quartzite, partly of granite) by about 65 feet. At the rate of erosion determined by C. C. Brittlebank for the Bacchus Marsh district of Victoria, such a work of erosion might have been done by a river like the Ringarooma in a period of time of the order of 100,000 years.

This would surely be older than the Würm glaciation, and would more nearly correspond with that of the Riss.

If, therefore, this flake was really *in situ*, as seems practically certain, it would put back the coming of man into Tasmania into perhaps the time of the Riss glaciation. At the same time, if the early part of the Würm glaciation dates back, as some think, to 50,000 years ago, the excavation of the present Ringarooma valley out of the

Section across Bass Strait

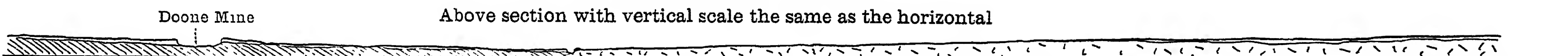




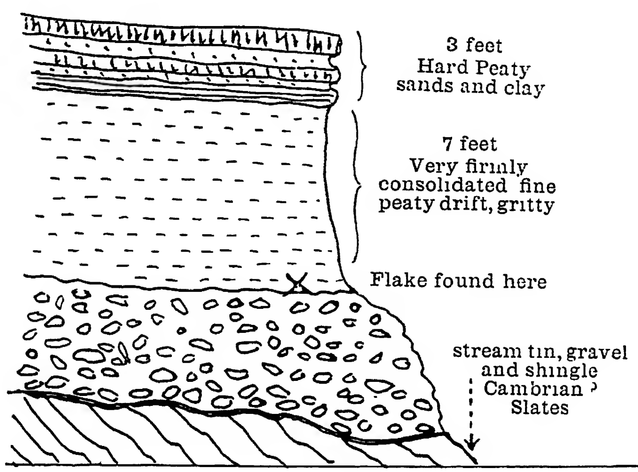
Chalcedonic aboriginal flake found at the Doone Mine at point X at 10 feet below surface.

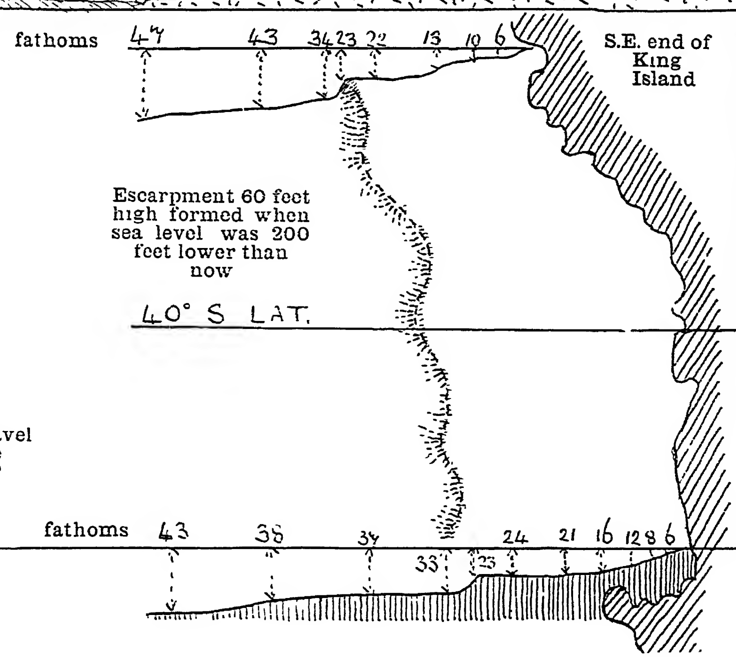
Length of section about 2 miles

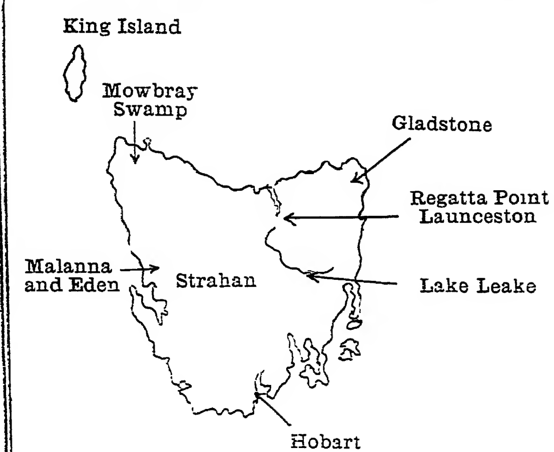
Above section with vertical scale the same as the horizontal



Section at Doone Mine







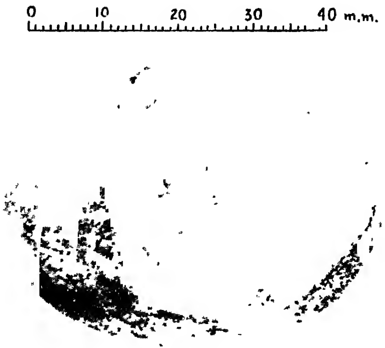


Fig. 1.

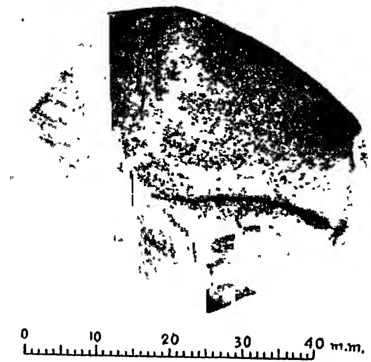


Fig. 2.

ARTEFACTS ("TRONATTA") OF PRE-HISTORIC TASMANIAN ABORIGINES.

Fig. 1. Pebble of Pre-Cambrian quartzite chipped by Tasmanian Aborigines to form a scraper. From 3-4 ft. raised beach at Regatta Point, one mile north of Launceston.

Fig. 2. Artefact formed of a pebble of subtranslucent greenish chalcedonic Pre-Cambrian quartzite, from 3-4 ft. raised beach, Regatta Point, Launceston. The artefact has been waterworn subsequent to being left on the beach.

outwash apron material and the undulating peneplain of hard rock on which it reposes, may very well have taken place in post-Würmian time.

Meanwhile this is the most important discovery up to date, as to the high geological antiquity of man within the Commonwealth.

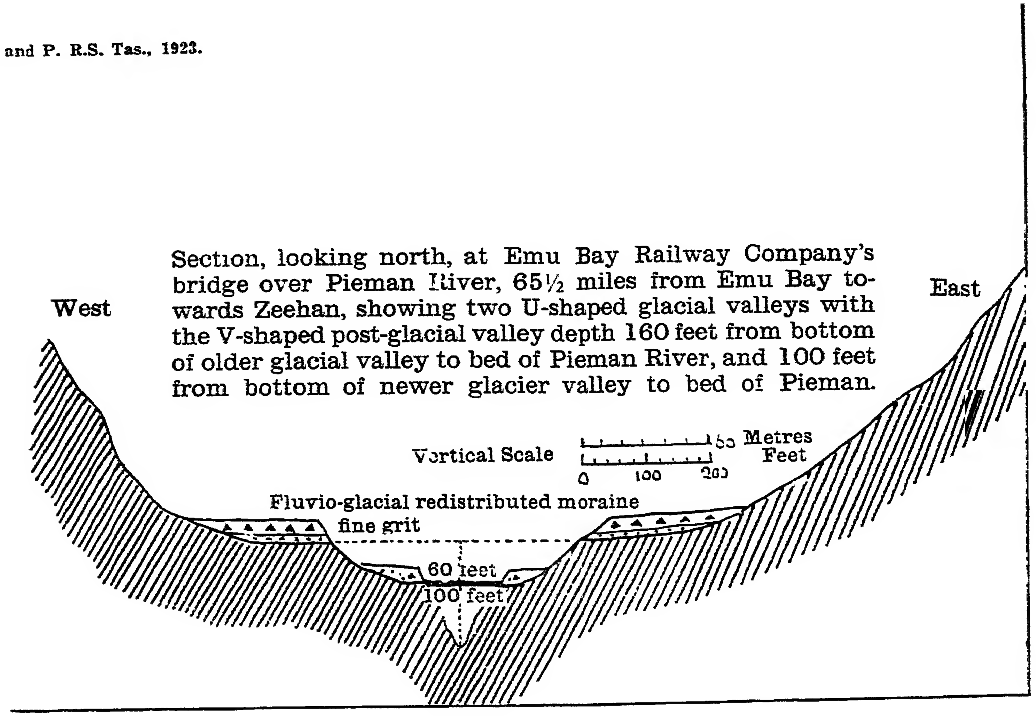
i.b. Last February the writer discovered at Regatta Point, one mile north of Launceston, on the east bank of the Tamar River, a large number (altogether about 100) of specimens of very roughly chipped implements formed out of pebbles embedded in the loosely cemented conglomerate of an old raised beach. So rudely fashioned were some of these implements that at first he doubted whether they were necessarily of human workmanship. The occurrence of these sharp-edged flaked stones alongside of well rolled shingle attracted attention as an anomaly in sedimentation requiring explanation. Eventually he discovered *in situ* a roughly chipped somewhat water-worn implement of sub-translucent chalcedonic quartzite, most obviously of human workmanship. At least 30 definite blows had been struck in order to fashion the implement into its present form. (See fig. 2 of Pl. X.) Unfortunately the original has been temporarily mislaid.

This raised beach is about 4-5 feet thick, and extends to at least 2-3 feet above high water spring tide, and is further covered by an overburden of about 8 feet of talus from the hill slope. The raised beach material is a ferruginous gravel, loosely cemented. The raised beach rests on Tertiary lacustrine leaf beds, perhaps of Miocene or Pliocene age. The raised beach belongs to the period, in the opinion of the writer, of a higher sea-stand, when sea level was perhaps 3-5 feet above what it is now. The maximum sea level of this epoch within the area of the Commonwealth averaged about 15 feet above present sea level, and dated back to a time suggested by R. A. Daly to be about 7,000 years ago. From this an age of perhaps 1,500 to 2,000 years may be deduced for this raised beach on the assumption that the decline in sea level took place at a uniform rate from 7,000 years ago down to the present time. The aborigines preferred a hard laminated pre-Cambrian quartzite for making their rough scrapers there. These were obtained from pebbles, in a gravel bed 8 feet thick and 85 to 110 feet above high water immediately above (to the east) the raised beach. A few scrapers are made

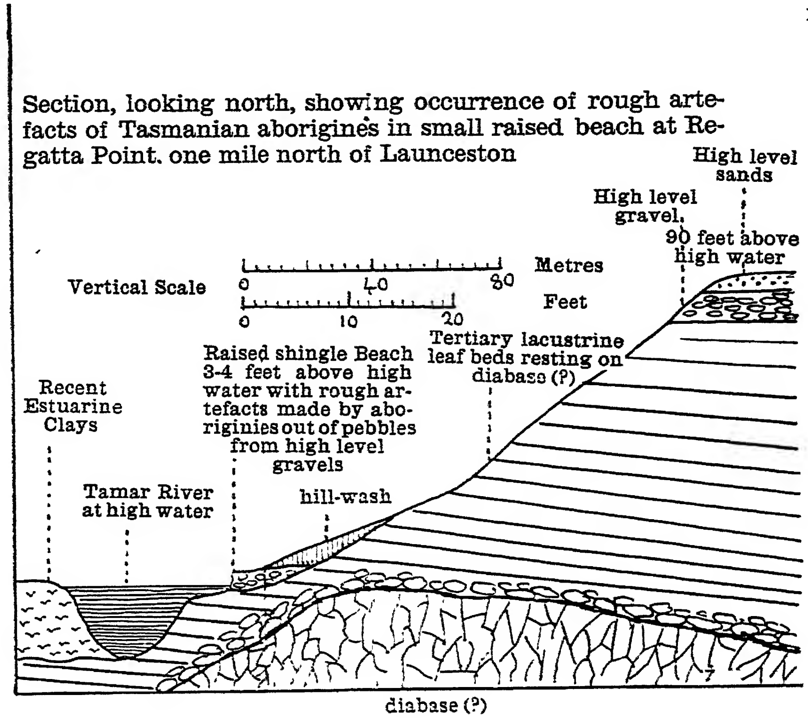
of diabase. These are rotted, through weathering, to a depth of from 1/16th to 1/10th of an inch. The writer thinks it would take over 1,000 years for diabase to weather to this extent. Many of the "cores" show discoloration due to the action of fire, which was evidently used to cause the pebbles to exfoliate in curved flakes.

More search in this area is much to be desired, as it might reveal an early stage in the evolution of the fashioning of stone implements by the Tasmanian aborigines. Only one implement formed of chert was found, among the 100 collected, at Regatta Point.

i.c. At Lake Leake last February the writer found over 100 specimens of stone implements of the Tasmanian aborigines in what appears to be the beach of an old lake before it became naturally drained. The site of the old lake has now been used as a reservoir so that the water level, as the result of the damming of the valley forming the present outlet of the reservoir, has now risen about 10 feet, to that of the small terrace where the implements were found. The writer takes this slight terrace to be a relic of an old shore line. It may be mentioned that under two miles to the south-east there is an aboriginal stone quarry, where large numbers of these implements were fashioned, all made from cherts. These cherts were formed by the alteration of Jurassic clay shales along their plane of contact with masses of intrusive diabase. The author would not press for this last piece of evidence proving any special geological antiquity for the "tronattas," but thinks it should be recorded, as the area is worthy of further investigation. Evidence i.b. conclusively proves geological antiquity to be something of the order of perhaps 1,500 years, for within the last 100 years no appreciable alteration has been observed in sea-level anywhere around the shores of Australia or Tasmania. i.a. can prove a far higher geological antiquity for man if the "outwash" apron material dates back to the Riss Pleistocene ice sheet. The locking up of so much ice to form the great Riss ice sheets might have lowered sea level all over the world to the extent of about 200 feet. The levels of the old valley gravels at the Tamar and Mersey Rivers, together with the submerged terraces at about 35 fathoms to the west of King Island, point to the sea level having been lowered in late geological time to the extent of about 200 feet, and to have paused long enough at this low level to enable it to cut back a terrace over 50 feet in



Section, looking north, at Emu Bay Railway Company's bridge over Pieman River, 65½ miles from Emu Bay towards Zeehan, showing two U-shaped glacial valleys with the V-shaped post-glacial valley depth 160 feet from bottom of older glacial valley to bed of Pieman River, and 100 feet from bottom of newer glacier valley to bed of Pieman.

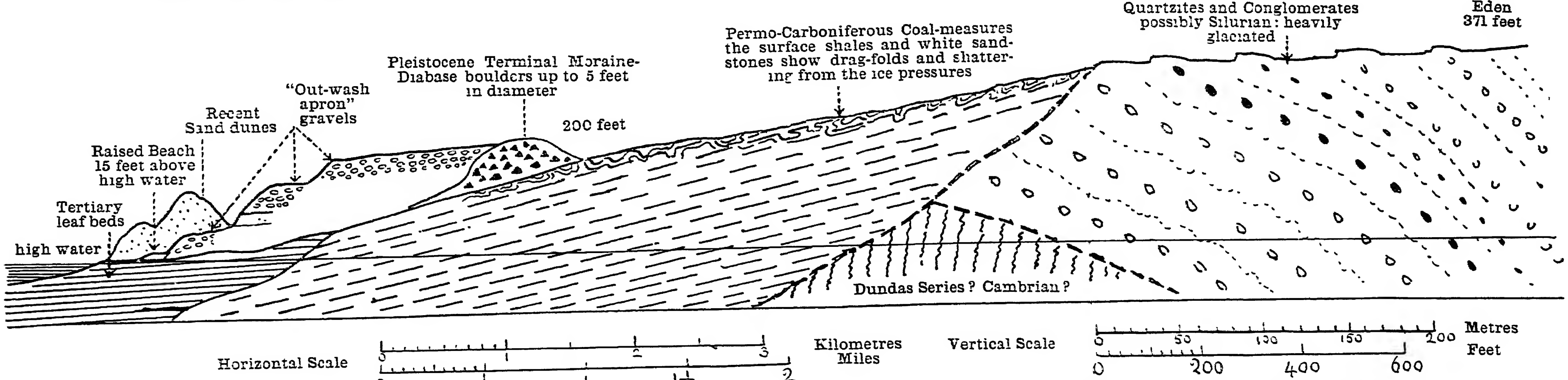


Section, looking north, showing occurrence of rough artefacts of Tasmanian aborigines in small raised beach at Regatta Point. one mile north of Launceston

West

East

Section 7 miles in length, from W. Coast of Tasmania, near mouth of Henty River, to Eden, showing the terminal moraine marking former maximum extension of the Pleistocene ice sheet, near Malanna, together with the "outwash-apron" ("schotter") gravels.



Above section with vertical scale the same as the horizontal with ideal restoration of the Pleistocene ice sheet with a thickness of 1000 feet at Eden.

Ice Sheet restored

height. The sea would in this case have completely retreated from Bass Strait and Torres Strait, and would have laid bare the bulk of the great Sahul shoal, or bank, and so have admitted of aboriginal Tasmanians migrating more or less dry-shod over the greater portions of the long road from their possible early home in the Malay Peninsula or Netherlands East Indies to Tasmania. The coming of aboriginal man into Tasmania may date back, on the above supposition, to a time of the order of 100,000, or more, years ago.

ii. Distribution and Number.

a. Of Stone Implements.

The stone implements of the aborigines, chiefly of the nature of scrapers for fashioning spears and throwing sticks and notching trees for climbing, are very widely distributed not only around the coast of Tasmania, but inland, particularly in the neighbourhood of the great lakes, such as the Great Lake, Lake St. Clair, etc. Some idea of the numbers may be formed from the fact that the writer last February, as the result of a quarter of an hour's search, picked up about 100 aboriginal chert flakes, almost all of which had been used as scrapers, near the present outlet of the Lake Leake Reservoir. These "tronattas" are strikingly like those found on the horizon of the remains of Piltdown man in Sussex.

b. Based on the Extent and Thickness of the Kitchen-Middens Along the Coast.

Some of the largest of these shell-mounds are to be found at Swanport, on the east coast of Tasmania. According to Mr. Clive Lord, one of these shell-mounds is no less than 10 feet deep in its highest part, and covers an area of several acres. The late Dr. Fritz Noetling attempted to estimate the approximate date of the coming of the first aborigines into Tasmania by the amount of material now to be found in the shell-mounds considered in relation to the average aboriginal population of Tasmania in the past. (1).

The aboriginal population of Tasmania is estimated at 2,000 in 1803. This population, he estimates, would consume shells of oysters, mutton fish (*Haliotis*), *Turbo*, etc., at the rate of about 120 cubic feet a year each. That would be

(1) Proc. Roy. Soc. Tasmania for 1910, pages 231-264. Plates I and II. The Antiquity of Man in Tasmania.

240,000 cubic feet a year, for the average rate of growth of the shell-mounds for a population of 2,000 aborigines. In 5,000 years the shell-mounds would have a capacity of no less than 1,200,000,000 of cubic feet. This would cover a tract of land about half a mile in width and ten miles in length, with kitchen midden to a depth of about 9 feet. Dr. Noetling concludes from this that, as this amount is probably in excess of the aggregate of all the shell material in all the kitchen middens of Tasmania, the first arrival of the Tasmanian aborigines may not have dated back more than 5,000 years from the present. That this is an underestimate would appear from the following:—

Firstly. The aborigines did not subsist on shell-fish alone, but partly on animal and plant food.

Secondly. For some considerable period of time after the coming of the first few individuals into Tasmania the population may have been considerably under 2,000.

Thirdly. The existing kitchen middens have been much reduced through various weathering processes, which have partly dissolved the shells, partly removed them by the mechanical agency of wind, water-floods, waves, etc.

Fourthly. A very important consideration is that as it is highly probable that the first coming into Tasmania of the aborigines took place during a low sea level, coinciding with one of the later Pleistocene glacial phases, the kitchen middens of that age, when sea level was some hundred to two hundred feet lower than it is now, have long since been completely submerged. If the home of the Tasmanian aboriginal was originally somewhere near the Malay Peninsula, some thousands of miles in length of shoreline, with intermittent shell-mounds, have been submerged along this assumed early road of migration. The estimate, therefore, of the date of the first arrival of the Tasmanian aborigines may have to be increased by many times the 5,000 years suggested by Dr. Noetling.

iii. Cultural Evidence.

a. Palæolithic stage of culture of the Tasmanian aborigines.

The Tasmanian aborigines had no shield nor womerah nor boomerang, and had no knowledge of putting a cutting edge on their stone implements by grinding them down on

another stone used as a hone stone. Their implements are distinctly of a Palæolithic type, strikingly like those of Piltdown man, but many of them show exquisitely fine finish by the method of re-touching, as proved by many fine specimens in the collections of the Tasmanian Museum, Hobart, as well as in those of Dr. W. L. Crowther, some of the best of which were collected near Ross and Oatlands. Their implements mostly show concave surfaces, evidently used for spokeshaving their spears and shaping their throwing sticks. These throwing sticks (Lughrana) had an effective range up to about 40 yards, and their spears (Perenna) up to about 60 yards. The latter, hardened at the point by fire, would go through the body of a man at a range of 60 yards. The club, waddy, or throwing stick was about 2 feet long, notched or roughened at one end to give a grip; sometimes knobbed at the other end. None of their stone implements was ever hafted. Occasionally in the kitchen middens may be found palettes of the nature of stone dishes, or shallow mortars, in which they ground their hæmatite for raddling their hair. They had no nets nor fish hooks, and do not appear to have eaten fish. The aboriginal women made neat baskets (Tughbrana), or "dilly-bags."

b. Tasmanian aborigines had no knowledge of making large dug-out canoes, or outrigger canoes, such as those used by the Australian aborigines from Hinchinbrook Island northwards to Cape York, or the large dug-out canoes, or the stringy-bark canoes used by the Australian aborigines from Carpentaria to west of Darwin. The canoes of the Tasmanian aborigines had a maximum length of 9 to 10 feet, a width of 3 feet, and a height of 1¼ feet, with a depth inside of about 9 inches. They were practically three cigar-shaped bundles of bark tied together with grass string or strips of kangaroo skin so as to form a rough canoe or slightly hollowed float. They were propelled by poles whether in deep or in shallow water. Crude craft as these were, the aborigines nevertheless were able to cross in them from the mainland to Maatsuyker Island and Maria Island; the latter involved a voyage of about 3 miles. The Seri Indians in Sonora (California) in their "balsas" (30 feet long bundles of reeds lashed together) can even cross the Gulf of California in calm weather. This is from 50 to 100 miles in width. (31).

That the formation of Bass Strait, or, at any rate, the western part of it, in which King Island lies, must date

back many thousands of years into the past, is suggested by the following consideration, among others:—

The marked differentiation of the Tasmanian emu and the King Island emu (respectively *Dromaius diemensis* and *D. péroni*) from the emu of the mainland, *D. novæ-hollandiæ*, surely demands a period of geological time to be estimated by more than just a few thousands of years, probably something more of the order of 20,000 to 50,000 years. It will be noticed that King Island would have been united to the mainland of Tasmania up to the latest date of the union of Tasmania with the Australian mainland, as the old eastern land bridge by way of Flinders Island and the King Island land bridge would both be restored if the ocean level were dropped by 30 fathoms.

iv. Anatomical and Physiological Evidence.

a. Alliance of Tasmanians to the primitive negrito races.

This matter will be discussed very briefly, the reader being referred to the works of reference by Professor Berry, Dr. S. A. Smith, etc., given in the Bibliography.

The Tasmanians living in the eastern half of the island were mostly of small stature, the average height of the men being 1661 millimetres=5ft. 5½in., that of the women 1503 mm.=4ft. 11¼in. The colour of their skin was rather more black than brown.

b. The mouth was big, and the teeth larger than those of any other existing race. They were ulotrichous. Cephalic index .75.

c. As regards a downward limit to the date of the Tasmanian aborigine, the fact must not be lost sight of that he was essentially *homo*, at all events, as far as relates to the types of him with which we are familiar. He had little special affinities with *Eoanthropus* or with *Pithecanthropus*.

d. Had the Tasmanian aboriginal been resident in a cool temperate climate like that of Tasmania for a vast period of geological time, one would have expected that the primitive blackness of his complexion, so characteristic of tropical peoples, would have shown some signs of passing into paler shades, such as light brown, or even white.

v. Associated Fauna.

a. It will be shown in the next division of this paper that the dingo at the Wellington Caves, in New South Wales,

and elsewhere on the mainland, was contemporaneous with extinct marsupials, such as *Thylacoleo*, *Diprotodon*, etc.; also at the Wellington Caves, a human molar tooth was found, apparently *in situ*, in the cave breccia. There can be little doubt that the dingo was brought into Australia by the early emigrating Australian aboriginal. The dingo, therefore, on the mainland, dates back to at any rate late Pleistocene time. The Tasmanian aborigines had no knowledge whatever of the dingo, which evidently was blocked from getting into Tasmania through the flooding of the old isthmus joining Tasmania to the mainland, by the waters of Bass Strait having already become "un fait accompli" before the dingo reached the shore of south-eastern Victoria. If, therefore, the Australian aboriginal dates back to late Pleistocene time, the Tasmanian aboriginal must be relegated to an older period still. Incidentally, it may be remarked that the survival in Tasmania of *Thylacinus* and *Sarcophilus* is directly due, in the opinion of Sir Baldwin Spencer, to the absence from that island of the dingo. *Thylacinus* and *Sarcophilus* ranged over nearly the whole of Australia in late Pleistocene time, but have now become wholly extinct through having been exterminated by the dingo.

b. Reference has already been made to this consideration (b) on page 119, and the reader is referred to the paper by Messrs. H. H. Scott and Clive E. Lord. With the exception of the bones of the extinct emu, *Dromornis australis*, showing evidence of having been hacked by aboriginal implements, according to the Rev. J. E. Tenison Woods, no traces have been found so far of any marks left by aborigines on bones of extinct vertebrates, either in Australia or in Tasmania. The bones of extinct kangaroo now preserved in the Ballarat Museum, and stated to show tomahawk cuts, must be looked upon as doubtful evidence of the contemporaneity of man. The observations of Heber Longman, Curator of the Brisbane Museum, show the clearest possible evidence of deeply-cut incisions made by the carnassial teeth of *Thylacoleo* on the bones of his herbivorous contemporaries. It is highly probable that careful search in the future may reveal the presence of some marks left by man on the skeletal remains of extinct marsupials or monotremes. This is a point to which the attention of future observers might well be directed.

TENTATIVE SUMMARY OF PLEISTOCENE AND RECENT DEPOSITS WITHIN THE COMMONWEALTH, SHOWING THE POSITIONS IN THE TIME SCALE OF EVIDENCES OF TASMANIAN AND AUSTRALIAN ABORIGINAL MAN.

Approximate Time in Years ago from Present.	Stage or Formation.	Geological Events.	Sediments.	Fauna and Flora.	Human Remains.
1,500-2,000 (?)		Subsidence of coastal block-faulted area, or eustatic negative movement of ocean? Newer Raised Beaches of Dry Creek near Adelaide, 11 feet above high water.	Sand dunes of Cape Otway, Peat beds of Coorong and Waukwine Range areas, South Australia, etc. Sands and clays. Uppermost beds of Delta deposits. Regatta Point, Launceston, raised beach, 3-5 feet.	*Ampullaria quoyana*, *Risella melanostoma*, etc.	Bone needles, stone tomahawks. Primitive types of stone scrapers.
6,000-7,000		Negative eustatic movement of ocean from 10 feet at King and Flinders Island, to 15 feet at W. Maitland, about the same at Townsville, and 23 feet near Fremantle. Seas warmer than now, for *Orbitolites complanata* has retreated equatorwards from Adelaide to Shark's Bay, where the sea water is 7 to 8 deg. Fahr. warmer than near Adelaide. Volcanic eruptions Mt. Gambier, South Australia, Tower Hill, Victoria. Possibly the crater of Lake Eachem, to the west of Cairns, Queensland, may belong to this epoch.	Basic lavas and tuffs. Terrestrial sands capped by fluviatile sediments followed in turn by marine estuarine shell beds.	*Arca trapezia*, *Orbitolites complanata*, *Mytilus menkeanus*, *Siphonalia maxima*.	Aboriginal clay basins and pounding stones at "Reedbeds" near Fulham, South Australia.
7,000 (?) to 12,000 (?)	Post-Würm Mountain glaciation.	Deglaciation with rising sea-level. Glaciation of National Park, Tasmania, specially near the 4,000 feet contour, marked by high level tarns at Kosciusko, and moraines near Townsend's Pass, Kosciusko, 6,400-6,700 feet altitude.	Estuarine peat beds, sands, and clays of Shea's Creek, Botany Bay, near Sydney. Silts of Lake Colungulac, Victoria. Lacustrine clays and silts of Lake Callabonna, South Australia. Cuddie Springs, N.S.W. Wellington Cave Breccias, N.S.W.	Existing species of Mollusca. Remains of Dugong (*Halicore australis*). *Eucalyptus botryoides*, *E. resinifera*, *Banksia serrata* in the peat. *Thylacoleo*, Dingo. Diprotodon, *Genyornis*, Dingo. Diprotodon, Dingo. *Homo* (?)	Four well-ground stone tomahawks at depths varying from 7 feet to 11 feet below high water level. One human molar tooth.

17,000 to 20,000 (?)	Würm Glaciation.	Last severe glaciation of Tasmania. Lakes formed in National Park at the 3,200-3,500 feet altitudes. Glaciation of Blue Lake, Kosciusko, at altitude of 6,150 feet.	Possible "outwash apron" stream tin drifts of the Doone Mine near Gladstone, the Pioneer Mine near Herrick, Tasmania. Torrential gravels (newest) of eastern Gippsland.		Aboriginal chalcedonic flake at 10 feet below surface in firmly compacted "outwash apron" drift? This may belong to the Riss Glaciation. (See below.)
20,000 to possibly 150,000	Riss-Würm Inter-glacial (Durntenian or Sangamon mild epoch).	Erosion. Old U-shaped valley of Pieman River, Tasmania, deepened by V valley which from Riss time to present-day has been deepened 100 to 130 feet in hard rock. Wide flats of Ringarooma Valley between Pioneer Mine and Doone Mine near Gladstone excavated in hard rock from this down to present time to depth of 50-60 feet. U-shaped valley of Snowy River, Kosciusko, below Charlotte's Pass, deepened by V-shaped notch, in hard granite, about 30 feet deep, from this date to the present.	Mowbray Swamp peat deposits.	Trunks of Dicksonia and shells of recent Mollusca and remains of *Nototherium mitchelli* and *N. tasmanicum*, etc. Older portion of the Darling Downs Pleistocene Fauna, *Euryzygoma dunense*, Heber Longman, found at depth of 60 feet.	Talgai Skull of Dalrymple Creek near Warwick, Darling Downs, Queensland.
90,000 possibly to 150,000	Riss Glaciation.	Morainic material of National Park, Tasmania, at altitudes of 2,500 to 2,800 feet.			? Aboriginal chalcedonic flake from near Gladstone, at 10 feet below surface in "outwash apron" drift.
250,000 to possibly 400,000	Riss-Mindel Inter-glacial (mild epoch), Helvetian or Tyrolean or Yarmouth. Mindel Glaciation.	Maximum development of the Tasmanian Pleistocene Ice sheets, and the "calotte" ice of Mt. Kosciusko.	Great terminal moraine with rotted blocks of diabase, 2 feet through, between mouth of Henty River and Lower Eden Valley, Western Tasmania, near Malanna. Out-wash apron gravels of Strahan. Kosciusko-Snowy River moraines at 5,000 feet level.		

B. Evidence of the Antiquity of Aboriginal Man in Australia.

To whatever date the first coming of the Australian aborigines into Australia be assigned, it is obvious that the first arrival of the Tasmanian aborigines in Tasmania antedates it.

It is next important for our inquiry to review any evidence as to the geological antiquity of man in Australia.

Such evidence may be classed as:—

i. Legendary.
ii. Based on the age of the deposits in which remains of man or any of his artefacts, or other traces of his handywork, have been found.
iii. Based on anatomical structure of the human remains.
iv. Based on the age of the dingo on the assumption that the dingo was introduced into Australia by the early Australian aboriginal immigrants.

i. Legendary.

a. James Dawson states, "An intelligent aboriginal "distinctly remembers his grandfather speaking of "fire coming out of Bo'ok (a hill near the town of "Mortlake, in Victoria) when he was a young man."

b. Dawson also states that when volcanic bombs from the extinct volcano of Mt. Leura were shown to an aboriginal native of Colac, Victoria, the aboriginal said that "these were stones, which his forefathers "told him had been thrown out of the hill by the "action of fire."

c. Similar legends of aborigines having seen Mts. Franklin and Buninyong in eruption have been recorded.

Too much reliance cannot be placed on these statements, especially the former, as the aborigines may have been practically repeating what they had picked up earlier from some white people.

ii. Evidence based on the age of the deposits in which remains of man or of his artefacts or other traces of his handywork have been found.

a. Bennett has recorded the finding of grooves made by aborigines honing down or sharpening their tomahawks on sandstone surfaces 30 feet below the sur-

face of the ground, the overlying material being the alluvium of the Hunter River, in the Maitland district, New South Wales.

In view of the rapidity with which the Hunter River changes its channel from time to time, as the result of floods, this evidence must be accepted with caution, as being quite inconclusive, unless supported by other evidence.

b. Gerard Krefft (7), (8), a former curator of the Australian Museum, Sydney, records the finding by himself of the "fractured crown of a human molar "tooth in the same matrix as *Diprotodon* and *Thyla-* "*coleo* at Wellington, in this colony" (the Wellington Caves of New South Wales).

Commenting on this remarkable discovery, Mr. R. Etheridge, jun. (7), concludes that this would be much the most important evidence up to date as to the geological antiquity of man in Australia, if it were certain that the molar had been found in the same mass of cave breccia as the remains of the extinct marsupials. There is still some of the red cave earth adherent to this tooth, which is preserved at the Australian Museum, but there is no trace of any adherent breccia. At the same time the statement of a scientist like Mr. Krefft, that he actually found the tooth in the breccia, must surely be accepted.

Mr. Etheridge has figured this tooth (*vide* Rec. Aust. Mus., XI., 2, p. 31, and Pl. 12, figs. 3-4, 'Exploration of Caves and Rivers of N.S.W." Parliamentary Paper 1882).

Important confirmatory evidence as to the tooth having been *in situ* in the breccia is supplied by the fact that teeth of dingo (*Canis dingo*) occur *in situ* in the bone breccia of the Wellington Caves, in association with bones of *Thylacoleo*, *Sarcophilus*, and *Diprotodon*. The value of this evidence rests, of course, on the assumption that the dingo was boated over to Australia by the early Australian aborigines (9).

c. Mr. James Bonwick (7) states, "at Ballarat, a basal- "tic stone weapon or tool-head, was unearthed in "in the process of gold-prospecting, 22 inches below "the surface, in a place which evidently had been "disturbed."

d. The late Rev. J. E. Tenison Woods states that bones of *Dromornis australis* have been found in South Australia, scraped and cut by aborigines. Unfortunately, no figure of these bones has been published, and the bones themselves cannot now be traced.

e. The late C. S. Wilkinson records that (39) in 1864 he found at a spot 2 miles east of the Cape Otway lighthouse, flint chips, and a sharpened stone tomahawk, and several bone needles. Mr. R. Etheridge, jun., has reported (6) that in 1865-66 he found a bone spike in beach material, formed of pebbles and broken shells, and apparently passing under the sand dunes. As the dunes near the scene of Mr. Wilkinson's discovery are 200 feet in height, it is assumed that the deposit is of some antiquity. In view, however, of the speed with which dunes come and go, this evidence seems inconclusive.

f. C. S. Wilkinson states (39) that "a stone hatchet has "been obtained on the Bodalla Estate, in the allu-"vium, at a depth of 14 feet." In the absence of details as to the rate at which this alluvium has accumulated, this evidence is of small value.

g. C. G. W. Officer describes the imprints of human feet and buttocks in the consolidated calcareous dune rock of Warrnambool. These are very possibly genuine human impressions, though some doubt this. In any case, they do not necessarily prove a high geological antiquity for man in that region (23).

h. Messrs. R. Etheridge, jun., T. W. Edgeworth David, and J. W. Grimshaw have placed on record (8) the finding of no less than four stone tomahawks at Shea's Creek, near Botany Bay, in the Sydney District.

In the same paper they describe and figure the remains of a dugong, the bones of which show conclusive evidence of having been hacked by aborigines. The top of the skeleton of the dugong was about 5 feet below mean high tide, and the base of the skeleton about 7 feet below. The skeleton was covered partly by peat, partly by estuarine clays. It is thought that sea level has risen by about 5 feet since the aborigines feasted on the dugong.

As regards the stone tomahawks, two were found at 11 feet below mean high water mark, in a sump hole, and are said to have been found in peat, or on the surface of the peat. Peaty beds were intersected there at various levels, the lowest bed occurring at 10 feet below low water. Numerous stumps of swamp mahogany (*Eucalyptus botryoides*), mahogany (*Eucalyptus resinifera*), honeysuckle (*Banksia serrata*), occurred *in situ* in the peat, representing a submerged forest. One of the banksia stumps at 10 feet below low water level, that is, at about 14 ft. below high water, showed clear evidence of having been burnt off at the top, while *in situ*. The roots were also charred. The burnt stump is not, in itself, conclusive evidence of the presence of man, as the fire may have been due to natural causes. In connection with this, it may be mentioned that in a bore put down by a geological party from the University of Sydney, with the assistance of Mr. G. H. Halligan, charcoal was found, obviously caused by a contemporaneous fire, at about 60 feet below sea level, near the southern end of the bridge over the Narrabeen Lagoon, about 7 miles north of Sydney Heads. Had only one stone tomahawk been found at Shea's Creek, at 10 feet below high water mark, it might have been argued that it was accidentally dropped overboard from a canoe, but the finding of no less than four between 7 and 11 feet below high water mark, taken in conjunction with the fact that the bones of the dugong, now buried to a depth of 7 feet below high water, under estuarine clays and peat, had been hacked by aborigines, is good proof that sea level in that locality has risen considerably to the extent of at least from 7 to 11 feet since the imbedding of the tomahawks. When it is considered that tidal observations in various harbours around Australia and Tasmania show no appreciable variation in sea level for the past fifty years, a variation of sea level, in so relatively stable an area as that of Botany Bay, of from 7 to 11 feet, probably indicates an antiquity of not less than a few thousand years.

i. Captain S. A. White (38) and Professor Walter Howchin (13) state that at the Reedbeds, near Fulham, South Australia, the sands and clays, on being

excavated, revealed three aboriginal basins, formed of clay. With these "dipping basins" for holding water on the surface of the sand [as practised now at Kisimayu, on the East Coast of Africa (*f.* S.A. White)] were found six undoubted artefacts, mostly pounding stones, hammer stones, etc. This was at a depth of approximately 8 to 9 feet below high water. Therefore, there has been a positive movement of the sea there, or a negative movement of the land of at least 8½ feet since man made the clay "dipping basins." This evidence, so remarkably in accord with that of Shea's Creek, is suggestive of a eustatic positive movement of the ocean since the occupation of the Adelaide and Sydney areas by aboriginal man.

j. Mr. Walter Enright (5) has recently recorded the occurrence of an aboriginal tomahawk *in situ* at Font Hill, near West Maitland, at 11 feet below the surface. This was found in a bed of clay at the Maitland Colliery Shaft.

iii. Based on anatomical structure of the human remains.

The Talgai Skull.

The state of mineralisation of this skull would not, in itself, be a proof of high antiquity, inasmuch as Dalrymple Creek, near Talgai Station, where it was found, deposits a considerable amount of carbonate of lime in a relatively short space of time. But the dentition is considered to be distinctly archaic. The left canine of the upper jaw is not only unusually large, but is separated from the adjacent tooth by a diastema, and is strongly facetted on the side where the canine of the lower jaw slid past it in such a way as gradually to grind this facet. Such an interlocking of the canine teeth, so characteristic a feature in the Piltdown man (*Eoanthropus dawsoni*) of Sussex, is, of course, a special attribute of the anthropoid apes. It should here be mentioned that Professor Keith considers that this skull has affinities with those of the Tasmanian aborigines, but his opinion is not shared by other anthropologists and anatomists. If, therefore, this skull be that of an Australian aboriginal, a later immigrant than the Tasmanian, the first coming of the Tasmanian into Australia must have been still more remote in time.

iv. Based on the age of the dingo on the assumption that the dingo was introduced into Australia by the early Australian aboriginal immigrants. (9).

Remains of dingo (warrigal) have been recorded at the following:—

a. At a cave in basalt on Toolern-Toolern Creek, 5 miles S.E. of Gisborne, in Victoria, in 1857, C. D'Oyly, H. Alpin, with Dr. A. R. C. Selwyn, found perfect skulls of dingo, of the Devil of Tasmania (*Sarcophilus ursinus*), etc. [2].

b. At Lake Colungulac, near Camperdown, cranial remains of dingo, as well as remains of *Thylacoleo carnifex*, were figured by McCoy from the lake alluvial deposits. [3].

c. From alluvial deposits at Lake Timboon, Co. Heytesbury, Victoria, R. B. Smyth states that remains of *Canis dingo* were found with those of *Sarcophilus ursinus*, Harris, *Macropus titan*, Owen, and *M. atlas*, Owen, and of *Nototherium* and *Diprotodon*. [4].

d. Smyth also states (*op. cit.*, p. 149) that in sinking a well at Tower Hill volcano, near Warrnambool, after penetrating 63 feet of basaltic tuff, dried grass of an old land surface was struck, then blue and yellow clay, and at further depth of 60 feet, that is, 123 feet below the surface, the skull and bones of a dingo were found. Much doubt, however, exists as to the authenticity of this discovery, and the statement is now discredited.

e. The late Professor R. Tate states [5] that the Warrigal and *Diprotodon* "whose remains are found be-"neath the ashes of the Mt. Gambier volcano" were contemporaneous. This statement is also now seriously called in question.

f. Krefft [6] records the occurrence of the first two molars of the lower jaw of a dog in a cave breccia from Wellington, New South Wales, associated with remains of *Thylacinus*, *Sarcophilus*, and *Diprotodon*. Mr. R. Etheridge, jun. [7], verified the occurrence of teeth of *Canis* in the cave-breccia specimens from Wellington, in the collections at the Australian

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(2) Selwyn, Q.J.G.S., XVI., 1860, p. 145.
McCoy, Ecol. Sur. Vict. Notes attached to Quarter Sheet, vii., N.W.
(3) McCoy, Prodromus Pal., Vict., Dec. vii., 1882, pp. 8 and 9.
(4) Smyth, Aborigines of Victoria, i., 1878, pp. 149-150.
(5) Trans. Phil. Soc. Adelaide, 1878-79 (1879), p. LXX.
(6) Geol. Mag. ii., 1865, p. 572.
(7) Mem. Geol. Sur. N.S.W., Ethnological Series, No. 2, p. 50.

Museum, Sydney. This evidence is important, as confirming that of the human molar tooth, already quoted.

g. Professor J. W. Gregory [8] records finding remains of *Canis dingo* associated with those of *Thylacinus*, in the N.E. part of the Lake Eyre region, on the Diamantina.

h. Professor Wood Jones (15) states that "the Dingo "falls into line with all the other races of domestic "dogs, in being of the true northern wolf type. "Moreover, in the large size of the carnassial teeth "he approaches nearer to the ancestral type than do "the other races of dogs of which I can obtain speci-"mens or records" (*op. cit.*, p. 258).

Wood Jones concludes that the Dingo, unaided by man, could never have crossed Wallace's Line (the Strait of Bali-Lombok), which is 15 miles in width, or other still wider straits separating Timor from the Sahul Bank, or the nearest other islands of the Netherlands East Indies from New Guinea. He summarises thus:—

"The progenitor of the Talgai man came with "his wife, he came with his dog, and with his dog's "wife, and he must have done the journey in a sea-"worthy boat, capable of traversing this unquiet part "of the ocean, with his considerable cargo. Be-"sides this living freight, and the food and water "necessary for the adventure, he carried other things "—he carried a knowledge of the boomerang, of the "basis of a totem system, and various other cultural "features, all bearing a strange suggestion of very "distinctly western origin" (*op. cit.*, p. 263).

All this evidence combines to show:—

1. That man in Australia was almost certainly contemporaneous:—

(a) with extinct marsupials such as *Diprotodon, Thylacoleo carnifex*, etc.

(b) With extinct birds such as *Dromornis australis*.

2. That the Dingo, or Warrigal (*Canis dingo*, or *Canis familiaris dingo*), was certainly contemporaneous with extinct marsupials in Australia, and that he was almost certainly introduced into Australia by aboriginal man.

(8) Dead Heart of Australia, pp. 78 and 152.

PART III.

SUMMARY.

The table herewith is only a very tentative and provisional attempt to approximate to the relative antiquity of the various evidences adduced as to the age of aboriginal man in Tasmania and Australia.

From the arguments already deduced the following conclusions may be provisionally drawn:—

(1) That the limiting of the date of arrival of the first Tasmanian aborigines to some such period as about five thousand to seven thousand years, on the evidence of the size of the refuse mounds or kitchen middens, left by the aborigines, is apt to mislead for the following reasons:—

First, the kitchen middens are liable to be considerably reduced in bulk through being dismantled by floods, winds, etc., as well as solution by rain water, so that they are very much smaller now than they formerly were.

Secondly, a large proportion of the aboriginal inhabitants of the island did not dwell along the coast, but subsisted on animals and plants, which they found useful for food, in the inland areas. Thus out of the total population of aborigines in Tasmania in 1803 of two thousand, as estimated by Dr Noetling, perhaps only one-half inhabited the coastal areas, and so contributed to the kitchen middens. If this has been so in past time, the limit assigned by Dr. Noetling of seven thousand years would have to be doubled.

Thirdly, that while the evidence of aboriginal flaked implements, *in situ*, in the cemented raised beach at Regatta Point, near Launceston, points to the aborigines having inhabited the northern part of Tasmania at a time when sea level was perhaps some three to five feet higher than it is at present (perhaps 1,500 to 2,000 years ago), the remarkable evidence of the Chalcedonic flake (beautifully finished by retouching by the aborigines) *in situ*, in a deposit probably of fluvio-glacial origin, near Gladstone, in N.E. Tasmania, carries the date back probably to an epoch approximately contemporaneous with some important phase of Pleistocene glaciation. If aboriginal man in Tasmania was really contemporaneous with one of the last great ice ages, he must have witnessed a sea level, perhaps no less than 200 feet lower than it is at present. This lowering of sea level was due to the locking up of enormous volumes of sea water which went to form some eleven millions of square miles of Pleistocene ice sheets.

Soundings of the sea between the Malay Peninsula and Tasmania show that, but for a few relatively narrow deep straits, such as those of Sunda, of Bali-Lombok, and the trench between Timor and the Sahul bank, the ancestors of the Tasmanian aborigines would have been able to cross over on dry land from that famous tête-du-pont for migrations across the Pacific of early man—the Malay Peninsula (if they ever came from that quarter)—all the way to Tasmania. Obviously, as Torres Strait is not more than sixty feet in depth, and Bass Strait about 180 feet (along the line of shallowest ridge connecting it with the mainland), a fall of sea-level of 200 feet would completely unite Tasmania with New Guinea. If the Tasmanian aborigines arrived by such "strange roads" as now "go down" beneath the sea, and if in the earlier stages of their wanderings they followed the shore lines, and subsisted largely upon shell-fish, the bulk, indeed perhaps by far the greater portion, of their kitchen middens would now be submerged, many of them under Bass Strait. This submergence would result from the gradual rise in sea level, due to the thawing of the huge ice sheets of late Pleistocene geological time.

2. Next, the absence of any knowledge of making sea-going canoes on the part of the Tasmanian aborigines, such as would tend to their negotiating safely a strait of the present width of Bass Strait, strengthens the belief that they must have crossed at a time when the straits were either far narrower than now, or did not exist at all. We are now in a position to estimate very approximate date in absolute time for the arrival of our aborigines in Tasmania. The evidence at Launceston pointing to a higher sea level than at present, to the extent of about three to five feet, belongs probably to the epoch of greater warmth than at present (about 4 deg. Fah.), which followed on soon after the final melting away of the last of the great Pleistocene ice sheets. This raised the sea level apparently all over the world by about fifteen feet. Subsequently, possibly through the resorption of sea water by very recently expanding polar ice caps, sea level has since been lowered by fifteen feet. If the maximum sea level, namely fifteen feet above its present level, took place seven thousand years ago, the Regatta Point evidence may indicate an antiquity of about 1,500 to 2,000 years. Obviously, this is an absolute minimum date. Next, it has been shown that the dingo was brought into Australia by the Australian aboriginal, the dingo being a domesticated wolf imported by the Australian aboriginal from Asia. This

evidence suggests that to whatever age the dingo belongs, the Australian aboriginal is equally old. Geological evidence shows that on the mainland the dingo was contemporaneous with some forms of extinct marsupials, such as *Thylacoleo*, *Diprotodon*, etc. This, alone, carries back the coming of the Australian aboriginal into Australia to many thousands of years ago.

3. If the aboriginal flake discovered in the Doone Mine deposit belongs to the Epoch of Würmian Glaciation, it may date back to 20,000 years. If, however, as seems not improbable. it dates back to the time of the Riss Glaciation, then the antiquity would be of the order of about 100,000 years.

4. The Talgai skull of the Darling Downs, near Warwick, in Queensland, although regarded by Professor Keith as essentially that of a Tasmanian aboriginal, is considered by others to be more Australian than Tasmanian. If the latter view is correct, the anthropoid ape characteristic evidenced in the size and facetting of the canines shows again the high geological antiquity of the Australian aboriginal.

5. This is supported by the occurrence of remains of dingo, and of a human molar tooth in the cave breccia at the Wellington Caves, in New South Wales, the dingo remains certainly, the human molar doubtfully, in association with remains of *Thylacoleo*.

6. However far back the date of arrival of the Australian aboriginal is pushed into the past, the coming of the Tasmanian must have been older still, for neither the Australian aboriginal nor the dingo has ever found his way into Tasmania. The obvious explanation is that at some time subsequent to the arrival of the Tasmanian aboriginal in Tasmania, during the low sea level which laid bare Bass Strait, the sea returned in its strength, as the result of the melting of the great Pleistocene ice sheets. and stopped the Australian aboriginal and the dingo from migrating into Tasmania.

7. We have seen that in the Northern Hemisphere the very early men, such as those of Heidelberg in Germany, and Piltdown in Sussex, date back to possibly over a quarter of a million years ago, whilst the ape man of Java, the *Pithecanthropus*, may be fully half a million years old.

Now as regards the backward limit in time for the Tasmanian aboriginal, it may be noted that their anatomical structure shows little approach to *Pithecanthropus*, or to the old men of Heidelberg or Piltdown. Piltdown man, in particular, is considered by Professor Grafton Elliott Smith and John

Hunter to be in the direct line of ascent of man from the ancestral stock from which the modern anthropoid apes diverged. If the age of Piltdown man is to be referred back to Günz-Mindel inter-glacial time, he might be 300,000 to 400,000 years old. The Tasmanian aboriginal would be newer than that.

8. The fact may again be emphasised that whereas there is little doubt that the earliest members of the human family inhabited the tropics, and had black skins, and that the black men slowly became white, as the result of living for thousands of years in cool temperate climates (and so we should expect that the Tasmanian aboriginal, if he had been in occupation of Tasmania for a very long period, would have shown some change in colour of his skin from black towards white), there is no evidence that the skin of the Tasmanian aborigines was other than black, right up to the time of their extinction in 1877.

On the whole, then, the evidence is in favour of the Tasmanian aboriginal having arrived in Tasmania between about twenty thousand and one hundred thousand years ago. As regards their original home, the opinion of the late A. W. Howett, later supported by Professor Griffith Taylor, is that they came from Asia, being closely allied to the negrito type of Semangs, who inhabit the highest ridges of the Malay Peninsula. These peoples have the same strongly curling hair, etc., as the Tasmanian aborigines. In the same region, but at lower levels, are aborigines known as the Sakai. These have many close affinities with the Australian aborigines.

The opinion, however, of Professor Sir Baldwin Spencer is that possibly A. W. Howitt's conclusions will now have to be modified. Spencer states in a letter to the writer: "The "Tasmanians are not now regarded as true Negritos. They "are probably a remnant of a very ancient ulotrichous "(woolly-haired) people, the ancestors alike of the Negritos, "now isolated in the Andaman Islands, Malay Peninsula, "(Semangs), and Philippines (Aetas), and possibly also of "the Tasmanians, but even this is doubtful as the Negritos "were brachycephalic (cephalic index, 80-85), whilst the "Tasmanians were dolichocephalic or mesaticephalic (ceph-"alic index, 75), and seem to represent a distinct offshoot of "these very early ulotrichous people, who may also have "spread beyond New Guinea to the Western Pacific."

In regard to the Australian aboriginal and his origin, Sir Baldwin states (also in a letter to the writer): "The Aus-"tralians of the present day seem to belong to a dolicho-

"cephalic, cymotrichous group, usually now spoken of as pre-"Dravidians, surviving relics of whom elsewhere are possibly "the 'Jungle Tribes' of the Deccan, the Veddas of Ceylon, "and the Sakai of the Malay Peninsula; but the Australians "have developed along various lines, perhaps independently of "contact with other peoples."

While, therefore, the original centre of dispersal of the Tasmanian aborigines is still in doubt, that of the Australian aborigines was probably in Asia, the home, too, of the dingo.

In regard to future geological researches on the antiquity of man within the Commonwealth, and particularly of the Tasmanian aborigines, attention should, in the opinion of the writer, be directed, *inter alia*, to the following:—

1. Systematic exploration of the oldest and largest kitchen middens, like those of Swanport, the Derwent Estuary, Macquarie Harbour, Mussel Roe, etc.

2. Search for aboriginal implements, etc.—
   (a) In the 15 feet (above high water) raised beach deposits of the E., N., and W. coasts of Tasmania, and the islands of Bass Strait.
   (b) In the older dunes, like those of King Island, Flinders Island, etc. Those of King Island have already yielded interesting remains of *Nototherium* and *Zaglossus harrissoni*.
   (c) In peat deposits, like those of Mowbray Swamp.
   (d) In cave deposits, like those of Mole Creek.
   (e) In older terraced river gravels, dating back into the Pleistocene, including fluvio-glacial "out-wash-apron" deposits.
   (f) At aboriginal "quarries" for stone for their stone implements, or at places where they dug out lumps of hæmatite for pounding into raddle for colouring their hair.
   (g) In any dredgings in Bass Strait or adjacent estuaries, or in excavations for harbour works, a very great *desideratum* for the dating of the first coming into Tasmania of the Tasmanian aborigines would be the zoning and correlation of the Pleistocene glacial and inter-glacial deposits of Tasmania, with a view to making a time scale for the Southern Hemisphere for comparing with the standard time scale of the Northern Hemisphere.

What seems to be specially needed is a systematic mapping of all the glacial evidences, beginning with the oldest, those on the West Coast. There the great terminal moraine, so well seen in the railway cuttings in the Lower Eden Valley, can be followed north and south, and the outwash-apron gravels together with their peat beds should be carefully differentiated. The retreat of the great ice sheets, belonging perhaps to Riss or Mindel, or even Günz time, should be carefully followed up, traces of terminal moraines, Kames (osars), drumlins, trend of grooves on pavements, carry of erratics, nature, thickness, and time value of varve clays should be noted, together with positions and boundaries of existing or silted up (most of these older Pleistocene glacial lakes have been silted up), glacial lake basins, often with a great rock bar (or "riegel") helping to form the lake. Then estimates of the former thickness of the ice sheet may be formed from a close study of the height up to which old glacial markings can be traced on "tinds," "horns," or "nunatakr." Afterwards evidences of the later glaciations superimposed on the older can be studied and mapped, culminating in the final small mountain glaciers.

Truly, a fascinating and awe-inspiring quest! Any one familiar with the phenomena of existing Polar ice sheets and Alpine glaciers can visualise the tiers of Tasmania under their snowy mantle with great glittering ice-fields between; can see the glorious sapphire blue of the deep crevasses where the ice sheet plunged down the steep mountain escarpments of the West Coast, and mark the long sinuous lines of moraine streeling away from nearby nunatakr to be lost to sight in the far distance; can hear the harsh roar of the sub-glacial stream rolling its tawny waters past the great terminal moraine, and spreading, far beyond, its alluvial fan of gravel and sand; can follow every phase in the retreat of the ice invader; the ponding back of the glacial streams to form lakes in rear of the terminal moraines, the silting up of the older lakes and their passing into peat swamps and button grass flats. And then, too, he can see all the wonderful phenomena of the re-advance of the ice, as told so well for Switzerland by Nussbaum, and finally view the highlands alone snow-covered, the white of the corrie glaciers, framed in dark rock, while all the rest of the isle is under a living garment of green.

What changes the Tasmanian man must have witnessed. Probably some of these glacial phases with the gradual drowning of the Bass land bridge, which so effectually check-

ed the Australian Pharaoh and his hounds on the Victorian bank. What difference, if any, ensued in his culture as the result of this isolation from the mainland?

Then with what animals was the Tasmanian man contemporaneous?

Did he see the marsupial rhinoceros alive, and, if so, did he defend himself against him with his spears and throwing sticks?

The whole problem teems with interest, and is worthy of devoted work from many workers.

Whoever may follow this trail in the future should never forget that the man who blazed it was the man whom we specially delight to honour to-night.

One cannot conclude this memorial lecture on the Geological History of the aborigines of the Commonwealth without some thoughts for the future as well as the past.

Unfortunately, most unfortunately, these most primitive children of men the genuine Palæolithic type of hunters, the Tasmanian aborigines, are extinct, have been extinct since 1877. Most unfortunately, our remaining Australian aborigines are fast becoming extinct. These people whom we have dispossessed of their hunting grounds, and mostly driven into the most inhospitable and arid areas of the Commonwealth, will soon share the fate of the Tasmanian aborigines, unless we quickly change our method of dealing with them, and cease interfering with their normal mode of life. They must not be allowed to live in houses, they must be discouraged from wearing more than the very minimum of clothing. They must be prohibited from opium, alcohol, and every form of the white man's vices. These conditions can be secured for them if we have the will, in two ways: (1) When they are in actual employment as stockmen, domestic servants, etc., on stations, by treating them firmly, but kindly, as I saw them treated by Mr. and Mrs. E. R. Kempe, on Sir Sidney Kidman's station at Macumba, near Oodnadatta. There they are healthy and happy. (Secondly). Where they are not in the employ of white people, they should have suitable reserves made and maintained for them as has been so eloquently advocated by Sir Baldwin Spencer, of Melbourne, and Captain S. A. White, of Adelaide. The North American Indians were becoming extinct until our American cousins seriously took up the subject of their preservation, and secured for tribes like the Navajo Indians suitable reservations, with proper hygienic regulations. Now the Navajos

have ceased to decrease in numbers, and are actually increasing. We could secure surely the same happy state of things for our Australian aborigines if we had the will to do it, and it is part of our solemn duty and service to humanity to have the will and to see that the lot of our aboriginal is made as happy as may reasonably be. This about the Navajos we have learnt through the recent Pan-Pacific Congress, and the Congress has made us realise more than ever before our responsibilities to the native races of the Pacific in our own or in mandated territories and protectorates (9).

Many of these highly interesting peoples have become extinct, many are fast becoming extinct, partly through diseases endemic in the islands, partly through diseases introduced by the white man.

At the Pan-Pacific Congress, Dr. Cumpston, Chief Medical Officer to the Commonwealth, weighed his words well when he said that if half the cost of a modern battleship were expended, over a period of five years, on eliminating diseases and providing proper hygienic conditions for the native races within the shores of the Pacific, all those distressing diseases of tonu (Yaws), filaria, hookworm, and many others which cause so much suffering and premature death, could be completely eradicated.

Surely, surely the great nations around the Pacific should co-operate without delay in setting in hand such a work not only for the sake of our own health, as well as that of the Pacific peoples, but for the sake of that humanity which should raise modern man to heights undreamed of by his Palæolithic ancestor.

Certainly the noble character whose memory we cherish so particularly to-day would, were he among us now, have been foremost in this pleading, for as Sir John Dodds has said of him: "The actions of his life appear to be governed by "those principles of justice and kindness towards others which "God has established as the only true guide to human conduct."

Carlyle says truly that man in this life is attended by "the Terrors and the Splendours." Johnston saw much of both, and who does not, but his face was set upon the Splendours, and we are thankful to him, devoutly thankful, for helping us to realise the good and grandeur and the sacred mystery in human life.

(9) The resolution of the Congress urging the need for the establishing of a Chair of Anthropology at an Australian University is to be submitted for, it is hoped, favourable consideration to the Federal Government.

This memorial to him stands for a sign and for a promise. For a sign that we honour him, for a promise that we always will honour duty so well and nobly done.

PART IV.

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TASMANIAN *HYMENOGASTRACEÆ*.

By L. Rodway, C.M.G.,

Government Botanist.

(Read 6th November, 1923.)

In the year 1911 I had the honour of reading to the Society a paper of a similar title. Since then, there have arisen reasons for additions and alterations. Our list of these forms is now so large that there appears little prospect that new species will come to light, wherefore the present appears to be a suitable time to revise the family.

The *Hymenogasters* are small underground tubers which produce their spores on basidia, generally 2, sometimes 4 on each basidium. The characteristic of the family is that the gleba *does not break down into a mass of spores and fibres* as in allied tubers, such as *Mesophellia, Scleroderma, Diploderma, Lycoperdon,* and *Geaster,* but remains as a series of contorted tubes or spaces without change at maturity, till broken up by decay or eaten by an animal. The genus *Secotium,* however, is intermediate between the *Hymenogasters* and the *Agarics.* Formed underground it tends to emerge at maturity, and has a more or less developed sterile portion, often piercing through the gleba to the apex, and the tramal plates approach the appearance of distorted gills. Some plants may equally well be placed in one group or the other.

Of the *Hymenogastraceæ,* we have in Tasmania six genera of more or less artificial grouping. Three of these have spores longer than broad, namely:—

Hymenogaster, with a fleshy gleba and rooting at the base.

Rhizopogon, with a fleshy gleba and strands of mycelium marking the surface.

Hysterangium, with a gelatinous gleba, and thick peeling peridium.

The other three have spherical spores:—

Octaviana, an apparent peridium, and a sterile base.

Hydnangium, an apparent peridium, and no sterile base.

Gymnomyces, no appreciable peridium, nor sterile base.

HYMENOGASTER, TULASNE.

Members of this genus are of a dry fleshy character. Peridium from thin and continuous with the trama to thick and almost gelatinous. Gleba fleshy, the hymenial cavities small and very convoluted, trama thin, formed of elongated cells. Not floccose, nor gelatinous. Spores generally elliptic or fusiform, generally rough, papillate or sulcate, rarely smooth. Sterile base present sometimes, piercing the greater part of the gleba.

The following are specific distinctions:—

albellus, spores ellipsoid, pale, rough.
maideni, spores ellipsoid, pale, smooth.
aureus, spores fusiform, allantoid, smooth.
fulvus, spores brown, obtuse, 6 x 3 μ
violaceous, surface gelatinous, violet. Spores brown, rough, 9 x 7 μ.
nanus, peridium thick, brown.
rodwayi, spores ribbed, gleba dark.
albidus, spores ribbed, gleba pale.

Hymenogaster albellus, Mass. et Rod. Irregularly globose, 1-3 cm., gray. Peridium nearly white, membranous. Gleba brown to ochraceous-brown, canals small, very tortuous. Spores ellipsoid, dark brown, one or both ends rather acute, exospore thick, often inflated into small warts, or into few large warts, or again into small wing-like expansions, 15-18 x 6-7 μ

Common throughout Tasmania. Collected by Dr. Cleland in New South Wales.

Hymenogaster maideni, Rod. Irregularly globose, 1-2 cm. Peridium white, very thin. Gleba white, becoming pale ochre when dry, tough, canals minute, very tortuous. Spores ellipsoid, one or both ends sub-acute, pale brown, smooth, 10-12 x 6 μ.

Rare. Near Hobart. Differing from *H. albellus*, chiefly in paler gleba and spores.

Hymenogaster aureus, n.s. Irregularly subglobose, mostly 1-2 cm., bright golden yellow, surface rugose. Peridium tough, yellow, about 0.5 mm., thick. Gleba compact, pale brown, canals small, numerous, contorted. Spores elliptico-fusiform, quite smooth, allantoid, pale yellow, 15-21 x 6 μ.

Differs from *H. albellus* in colour, thickness of peridium, and glabrous, allantoid spores.

Mt. Wellington, 3,000 feet.

Hymenogaster fulvus, Rod. Irregularly globose, 1-4 cm. diameter, pale gray, becoming black with age. Peridium very thin, membranaceous. Gleba dense ochre, becoming dark brown. Canals numerous, tortuous. Spores oblong, brown, obtuse, 6-7 x 3-3.5μ.

West Coast and about Hobart Collected in South Australia by Dr. Cleland.

Hymenogaster violaceus, Mass. et Rod. Globose violet and white, with a viscid surface. Peridium thin, but distinct. Sterile base from obsolete to piercing to the apex, and broken into limbs. Gleba dense, the tortuous canals small, pale, becoming dark brown. Spores broadly ellipsoid, obtuse, brown, verruculose, 9 x 7μ.

Fairly common.

Hymenogaster nanus, Mass. et Rod. Irregularly globose. Often 2-3 cm. diameter. Outer layer of peridium of a firm gelatinous consistency, 1-2 mm. thick, inner layer membranous. Sterile base usually well developed. Gleba fleshy, dark brown, cells wide. Spores dark brown, ellipsoid, minutely verruculose, 15 x 7μ.

Unfortunately the first specimens sent to Massee were very small, hence the inapplicable name.

Cascades, Hobart.

Hymenogaster rodwayi, Mass. Irregularly globose, 1-3 cm. diameter, colour gray-white. Peridium fleshy, about 1 mm. thick. Gleba compact, dull dark brown, sterile base from obsolete to spreading in strands nearly to the surface. Spores ellipsoid, longitudinally furrowed, usually both ends acute. Ochraceous when young, then brown, 18-20 x 9μ.

Fairly common in Tasmania. Collected in New South Wales by Dr. Cleland.

Hymenogaster albidus, Mass. et Rod. Irregularly globose, 1-2 cm., usually clothed with floccose mycelium; white. Peridium membranous, very thin. Sterile base, slight or none. Gleba at first pinkish-white, becoming ochre-brown with age. Cells small, very tortuous. Spores ellipsoid, obtuse, yellowish-brown, longitudinally carinate, 20-25 x 15μ.

Cascades, Hobart. Rare.

RHIZOPOGON, TULASNE.

Peridium thick and persistent or thin and disappearing with strands of mycelium traversing its surface. Cavities distinct at first empty, spores smooth.

rubescens, red externally.
luteolus, white, then brownish-olive.

Rhizopogon luteolus, Tulasne. Irregularly globose, 2-6 cm. diameter; peridium ochre-yellow, very thin. Gleba rather dense, at first pale, smoky, then dark ochre-brown, or greenish. Tubes contorted up to 300μ. diameter. Spores oblong, obtuse, smooth, pale olive, 8 x 2μ

Sandy Bay, beneath Pines. Snug Falls track, with no conifers near. Collected in Victoria. Common in Northern Hemisphere.

Rhizopogon rufescens, Tulasne. Subglobose, 2-4 cm. diameter, red-brown; peridium thin, marked with mycelial strands. Gleba white, becoming yellowish with age, sometimes brown when very old, dense, canals minute. Spores narrow oblong, hyaline, or slightly tinted, 11 x 4μ.

Common under Pines. Cosmopolitan.

HYSTERANGIUM, VITTADINI.

Peridium distinct, separable; gleba at first mucilaginous, becoming gelatinous, cavities at first empty; spores smooth.

affine, gleba greenish-blue.
burburianum, gleba brownish-green.
pumilum, dwarf gleba ochraceous.
viscidum, surface red-brown, viscid.
atratum, surface pale purple, viscid.
neglectum, peridium thick, fleshy brown, not viscid
obtusum, peridium thick, violet, not viscid.
clathroides, waxy consistency throughout.
inflatum, exospore inflated.
membranaceum, delicate white to pale brown, turning indigo where bruised.
fusisporium, white, drying ochre, spores fusiform, shining.

Hysterangium affine, Mass et Rod. Globose, seldom exceeding 1 cm. diameter. White to pale brown; peridium white, leathery, 1 mm. thick, readily separating from the

gleba. Gleba dense, greenish or bluish, gelatinous. Canals small, not crowded, tortuous. Spores ellipsoid to fusiform, obtuse to sub-acute, smooth, slightly tinted, 11-13 x 5-6 μ.

Common in Tasmania.

Hysterangium burburianum, Rod. Globose, 1-2 cm. diameter, pale brown; peridium leathery, easily separating, 1 mm. thick. Gleba gelatinous, pale brownish-green, canals numerous, convoluted, walls thin. Spores oblong, smooth, obtuse, 5 x 3 μ

Differs from *H. affine* by paler gleba, and the smaller obtuse spores.

Collected near Launceston.

Hysterangium pumilum, Rod. Globose, pale ochre, cæspitose, 2-3 mm. diameter. Peridium thin, dark, horny. Gleba gelatinous ochre. Canals relatively large, not crowded, little convoluted. Spores smooth, hyaline, fusiform, 12 x 4 μ.

Differs from small specimens of *H. affine* in small size, cæspitose habit, pale gleba, and broader canals.

In heathy soil. Tasman's Peninsula.

Hysterangium viscidum, Mass. et Rod. An irregularly globose tuber, mostly 2-3 cm. diameter, viscid, chestnut-brown; peridium rather thick, tough, readily separating from the gleba. Gleba at first pale, but dotted by the minute brown canals, becoming dark brown with age. Spores broadly oblong, very obtuse, dark brown, minutely papillate, 12-14 x 8-10 μ

In gullies near Hobart.

Also collected in South Australia by Dr. Cleland.

Hysterangium fusisporum, Mass. et Rod. Irregularly globose, mostly 2 cm. broad, white to cream coloured, becoming darker with age, surface very rugose. Peridium very thin, papery, white. Gleba soft dense, but not as gelatinous as that of most members of the genus, white, drying pale yellow, canals small, very convoluted. Spores ellipsoid to fusiform, mostly acute at one or both ends, hyaline, shining, smooth, 20-22 x 8 μ.

Fairly common throughout Tasmania.

Hysterangium clathroides, Vittadini. Very irregular in shape, about 2 cm. in diameter; peridium thin, floccose continuous with the surrounding mycelium. Gleba gray-hyaline,

soft, almost waxy. Canals free, little tortuous, narrow, pale brown. Spores ellipsoid, acute at both ends, smooth, pale brown, 10 x 5 μ.

Knocklofty, Hobart. Rare.

Hysterangium neglectum, Mass. et Rod. An irregular tuber, 2-3 cm. diameter, ochre coloured; peridium thick, fleshy, not viscid, not readily separating from the gleba. Gleba dark, rich brown, sub-gelatinous, canals minute tortuous. Spores ellipsoid, light yellow-brown, rather obtuse, smooth, 12-8μ.

Very near *H. viscidum*, only different colour, not viscid, more gelatinous gleba, and distinct spores.

Found in many parts of Tasmania.

Hysterangium inflatum, Rod. Globose, reddish-brown, smooth, about 1 cm. diameter; peridium fleshy, about 1 mm. thick, readily peeling from gleba. Gleba blue-black, very gelatinous, canals not crowded, but very tortuous. Spores almost fusiform, very pale, smooth, 12 x 4μ, enclosed in a dilated exospore, much inflated above, reducing towards the base.

With a darker gleba than in *H. affine* it has distinct spore structure.

Rare. Mt. Wellington.

Hysterangium atratum, Rod. Subglobose, 1.5-2 cm. diameter, pale purple, smooth, viscid, becoming dark brown when old; peridium thin, gelatinous, readily peeling. Gleba clay-coloured, changing to dark brown, canals small, but numerous. Spores very dark brown, minutely rough, nearly spherical, mostly 11.5-11μ

Near *H. viscidum.* It differs besides general features by the rounder and even darker spores.

Mt. Nelson.

Hysterangium obtusum, Rod. Irregularly subglobose, pale pink-violet, becoming ochraceous when dry, mostly 2 cm.; peridium thick, deep violet. Gleba pale slatey olive. Spores ellipsoid, very obtuse, smooth, hyaline, 9 x 4μ.

Differing from *H. affine* by the thick violet peridium and smaller and more obtuse spores.

Mt. Nelson.

Hysterangium membranaceum, Vittadini. Irregularly globose, 1-2 cm., delicate, white, becoming blotched with indigo. Peridium very thin, dry, subtomentose. Gleba white or tinted with indigo, ochraceous with age. Spores ellipsoid, smooth, pale brown, 12 x 6μ.

Not common, but cosmopolitan.

OCTAVIANA, VITTADINI.

Peridium cottony. Sterile base distinct. Trama byssoid. Canals small contorted. Spores spherical.

carnea, pink, spores finely echinulate.
australiense, brownish, spores verruculose.
levispora, pale to light brown, spores glabrous.

Octaviana australiense, Berk et Br. Subglobose, mostly 2 cm. diameter, smooth, cream coloured to chestnut-brown, according to age. Peridium thin, tough. Gleba cream-coloured, then pink-brown, pierced below more or less by arms from the sterile base, canals about 1 mm., very contorted. Spores globose, with an irregular surface, or smooth, pale yellow, 9-12μ.

When young it will exude white milky fluid when cut.
Common in Tasmania. Widely spread in Australia.

Octaviana carnea, Wallr. Irregularly subglobose, 1-3 cm., smooth, pale-pink. Peridium thin, papery, or cottony, hardly appreciable. Gleba pink and white, cells very numerous and contorted, walls thin, sterile base, well developed. Spores globose, finely echinulate, white, 9-10μ.

Cosmopolitan.

Octaviana levispora, nom. nov. Irregularly globose, 2-3 cm., white, then gray or very pale brown. Peridium thin floccose. Sterile base, sometimes well developed, sometimes obsolete. Gleba white, then pale brown, dense, the canals small and tortuous. Spores spherical, pale brown, smooth, 9-10 μ. Peridium much thinner than in *Octaviana australiense*, and the canals smaller, but the spores similar.

Tasman's Peninsula.

HYDNANGIUM, WALLROTH.

Peridium fleshy or thin, smooth or silky, sterile base absent; cavities minute irregular, or occasionally larger and not contorted. Spores globose or subglobose, seldom smooth.

The genus may readily be divided into two sections:—

Contorta, in which the canals are very small, much contorted and empty.

Compacta, in which the sporogenous cavities are roughly iso-diametric, and crammed with spores.

Of the *Contorta*:—

brisbanensis, yellow, spores verruculose.
hinsbyi, ochre-brown, spores sub-echinulate.
glabrum, spores hyaline, smooth.

Of the *Compacta*:—

Sporogenous cavities about 1 mm. diameter.

tasmanicum, spores 11μ., brown, echinulate.
clelandi, spores 11μ., black verrucose.
mc'alpinei, spores 21μ., yellow verrucose.

Sporogenous cavities much under 1 mm.

alveolatum, spores alveolate.
microsporium, spores 5-6μ., verrucose.
densum, spores brown, echinulate.

Hydnangium brisbanensis, Berk. et Br. Irregularly globose, yellow, becoming brown when old, no sterile base, 1-3 cm., surface rugose. Peridium under 1 mm. but tough. Gleba ochre to ochre-brown, tubes numerous, small, very contorted, mostly 0.3 mm. Spores globose, pale-ochre, obscurely verruculose or minutely echinulate, 7-8μ. diameter.

North-East Tasmania. Reported from Queensland and Victoria. Many collections in New South Wales by Dr. Cleland.

Hydnangium hinsbyi, n.s. Irregularly globose, rugose, ochre-brown, 1-3 cm. diameter. Peridium thin, hardly apparent. Gleba rather dense, no sterile base, umber, canals small, numerous, contorted. Spores globose, light brown, densely covered with small erect, obtuse asperities, appearing echinulate under a low power, 9-12μ.

West Coast of Tasmania.

Hydnangium glabrum, Rod. Irregularly globose to oblong, mostly about 1 cm. diameter, surface smooth, dull chestnut-

brown. Peridium thin and continuous with the trama. No sterile base. Gleba at first pale, then brown, tubes convolute very irregular in size. Spores globose, smooth hyaline 6 μ. diameter. Often the exospore dilated and making the spore 8μ., with a double contour.

Distinguished from *H. australiense* by the dense gleba and small hyaline spores.

Cascades, Hobart. Collected in South Australia by Dr. Cleland.

Hydnangium tasmanicum, Kalchbr. Globose, gray, becoming dark with age, 1-2 cm. diameter. Peridium thin. tough, continuous with the pale trama; canals 1-2 mm. diameter, irregular, but little contorted, stuffed full of brown spores, giving the surface a marbled appearance. Spores globose, coarsely echinulate, dark brown, 10-12μ. diameter.

Found occasionally in Tasmania.

Hydnangium mc'alpinei, Rod. Irregularly globose, ochre-coloured, surface rough, 1-3 cm. diameter. Peridium tough, about 0.5 mm., thick, continuous with white trama. Gleba dense, canaliculate spaces, 1-2 mm. broad, not at all contorted, black with dense masses of spores. Spores globose, dark brown to black, rough, with small dark warts, 9-12μ. diameter.

Mt. Nelson, Hobart. Also collected in South Australia by D. McAlpine.

Hydnangium clelandi, Rod. Irregularly globose, whitish ochre, 1-2 cm. diameter. Peridium thin, membranous, white, continuous with the trama. Gleba dull brown-clay to umber, becoming browner with age, cavities about 1 mm., not contorted, but densely crowded with spores. Spores pale-yellow, globose, smooth, becoming obscurely verrucose, 20-22 μ. diameter.

Cascade Valley, Hobart.

Hydnangium alveolatum, Cke. et Mass. Globose, 1-1.5 cm., whitish ochre. Peridium distinct, continuous with the trama, becoming dark. Gleba soft, waxy, solid, trama pale, becoming dark, cavities minute, pale, not contorted. Spores globose, hyaline to pale brown, minutely alveolate, 10-12 μ. diameter.

Cascades, Hobart. Also in Victoria.

Hydnangium microsporium, Rod. Globose, white to pale ochre. Peridium rather thick and tough. Gleba dense, orange to raw sienna; cavities round about 0.5 mm. diameter, not contorted, full of spores. Spores hyaline, globose, armed with short spines or warts, 5-6 μ. diameter.

Mt. Nelson.

Hydnangium densum, Rod. Globose, 5-8 mm., ochraceous. Peridium 0.5 mm., thick, leathery. Gleba marbled with black from the spore masses; trama white. Canals round, not convoluted, 0.3 mm. diameter, densely packed with spores, black. Spores globose, brown, minutely echinulate. 12 μ. diameter.

Mt. Nelson.

In one specimen the base had few small canals, giving the appearance of a sterile base.

GYMNOMYCES, MASS. ET ROD.

Peridium none or rudimentary. Gleba fleshy; hymenial spaces numerous, not much contorted, trama thin. Sterile base absent, except in a few isolated tubers. Spores hyaline, globose, rough or echinulate.

pallidus, white, spores verruculose.

seminudus, white, spores echinulate.

flavus, yellow, spores echinulate.

Gymnomyces pallidus, Mass. et Rod. Subglobose, 2-3 cm. diameter, white, becoming light ochre when old. Peridium obsolete. Gleba dense, fragile white, canals small, very contorted, tramal plates white, very thin. Spores globose, hyaline, verruculose, 9-10 μ. diameter.

Cascades, Hobart.

Gymnomyces seminudus, Mass. et Rod. Globose; white, then tinted with ochre, 2-4 cm. Peridium very thin, continuous with the trama. Gleba white, tougher than in *G. pallidus,* canals minute, very contorted, irregular, tramal plates white, rather firm. Spores hyaline, globose, strongly echinulate, 11-12 μ. diameter.

Cascades, Hobart.

Gymnomyces flavus, Rod. Subglobose, but very irregular in shape and size, mostly from 5 to 10 mm. diameter, dull canary yellow when fresh, ochraceous when dry. No peridium; the surface floccose and marked by protruding hymenial canals. Gleba fragile, canals broad, numerous, contorted, trama thin, fleshy. Spores globose, hyaline, 10-11 μ. diameter, armed with broad, short spines.

Common in Southern Tasmania.

Gathered in New South Wales by Dr. Cleland.

f. tetraspora. Gleba less compact. Spores armed with longer spines and adhering in fours.

Cascades, Hobart.

The following described species are here suppressed:—

Hymenogaster barnardi, too near *Hys. fusisporum*
Octaviana archeri, no sufficient description.
Gymnomyces solidus, too near *G. pallidus.*
Hymenogaster levisporus, referred to *Octaviana.*

THE ROYAL SOCIETY OF TASMANIA

ABSTRACT OF PROCEEDINGS

1923

26th FEBRUARY, 1923.

Annual Meeting.

The Annual Meeting was held at the Society's Rooms, the Tasmanian Museum, Hobart, on the 26th February, Mr. L. Rodway, C.M.G., Vice-President, presiding. The Annual Report and Statement of Accounts were read and adopted. The following were elected as members of the Council:—Messrs. W. H. Clemes, W. H. Cummins, Dr. W. L. Crowther, Major L. F. Giblin, The Right Reverend Dr. R. S. Hay, Messrs. J. A. Johnson, J. Moore-Robinson, L. Rodway, and Dr. Gregory Sprott. Mr. R. A. Black was appointed Hon. Auditor.

Mr. Rodway exhibited specimens of *Milligana lindoniana.*

Papers.

The following papers by Messrs. H. H. Scott and Clive Lord were read:—

1. Pleistocene Marsupials from King Island.
2. *Nototherium victoriæ.*
3. *Macropus anak.*

Illustrated Lecture.

Professor Sir T. W. Edgeworth David delivered an illustrated lecture on "Recent Observations of the Pleistocene Ice-Age and its Relation to the Coming of Man into Tasmania."

Conversazione.

At the conclusion of the meeting a conversazione was held in the Art Gallery.

16th APRIL, 1923.

The Monthly Meeting was held at the Society's Rooms on the 16th April, Mr. L. Rodway, C.M.G., presiding.

The following members were elected:—Drs. A. W. Green and A. L. McAulay, Messrs. J. C. Breaden, J. A. Gorringe, G. H. B. Rogers, and H. C. Webster.

Paper.

The following paper was read:—

"Notes on a Geological Reconnaissance of Mt. Anne and the Weld River Valley, South-Western Tasmania." By A. N. Lewis, M.C., LL.B.

Illustrated Lecture.

Major L F. Giblin delivered an illustrated lecture on the Mount Anne District.

14th May, 1923.

The Monthly Meeting was held at the Society's Rooms on the 14th May, Mr. L. Rodway, C.M.G., presiding.

The following members were elected:—Captain Bowerman and Mr. F. L. Gunn.

The matter of the Cradle Mountain-Lake St. Clair Reserve was referred to, and it was resolved to communicate with the Government in reference to the matter.

Mr. Rodway drew attention to the need for a Gun Act, and tabled the New South Wales Act.

Illustrated Lecture.

Mr. E. T. Emmett, Director of the Tasmanian Tourist Bureau, delivered a lecture on "The National Parks of the World."

11th June, 1923.

The Monthly Meeting was held at the Society's Rooms on the 11th June, Mr. L. Rodway presiding.

The following members were elected:—Messrs. R. Gibbings, G. A. Purcell, and R. Harley.

Illustrated Lecture.

Mr. L. Rodway delivered a lecture entitled "Studies in Tasmanian Flora," the lecture being illustrated by a large number of lantern slides specially prepared by Mr. J. C. Breaden.

9th July, 1923.

The Monthly Meeting was held at the Society's Rooms on the 9th July, Mr. L. Rodway presiding.

The following members were elected:—Mrs. G. H. Butler and Dr. G. M. Parker.

Papers.

The following papers were read:—

1. *Vinculum sexfasciatum*, an addition to the Fish Fauna of Tasmania. By Clive Lord, F.L.S.
2. A Note on the Burial Customs of the Tasmanian Aborigines. By Clive Lord, F.L.S.
3. Mollusca of King Island. By W. L. May.

Illustrated Lecture.

Mr. Clive Lord delivered an illustrated lecture on "The Economic Importance of the Tasmanian Fauna."

6th AUGUST, 1923.

The Monthly Meeting was held at the Society's Rooms on the 6th August, Mr. L. Rodway presiding.

Papers.

The following papers were read:—

1. Australian *Bombyliidæ*. By G. H. Hardy.
2. Australian *Dixidæ*. By A. Tonnoir.
3. Studies in Tasmanian Mammals, Living and Extinct, No. XI. By H. H. Scott and Clive Lord.
4. An Experimental Method for Determining the Properties of Optical Gratings. By Dr. A. L. McAulay.

Mr. J. Moore-Robinson presented a statement dealing with the history of the first clock placed in Old St. David's Church.

Illustrated Lecture.

His Lordship the Bishop of Tasmania, the Rt. Rev. Dr. R. S. Hay, delivered a lecture on "The Historical Associations of the County of Durham."

11th SEPTEMBER, 1923.

The Monthly Meeting was held at the Society's Rooms on the 11th September, Mr. L. Rodway presiding.

Reference was made to the death of Mr. Dudley Le Souef, Director of the Melbourne Zoological Gardens.

Mr. P. Thomas gave an interesting note of a graft hybrid apple which was placed on exhibition.

Lecture.

Mr. L. Rodway delivered a lecture entitled "Botanical Notes."

8th October, 1923.

The Monthly Meeting was held at the Society's Rooms on the 8th October, Mr. L. Rodway presiding.

The following papers were read:—

1. Description of Two Underground Fungi. By L. Rodway.
2. Notes on the Tasmanian Emu. By H. H. Scott.

R. M. Johnston Memorial Lecture.

Professor Sir T. W. Edgeworth David delivered the first R. M. Johnston Memorial Lecture, and the Chairman presented Professor David with the R. M. Johnston Memorial Medal.

Conversazione.

At the conclusion of the meeting the members adjourned to the Art Gallery of the Museum, where a conversazione was held.

6th November, 1923.

The Monthly Meeting was held at the Society's Rooms on the 6th November, Mr. L. Rodway presiding.

The Chairman extended a welcome to the visiting delegates attending the Royal Australasian Ornithologists' Union Conference.

Paper.

The following paper was read:—

Tasmanian *Hymenogastraceæ.* By L. Rodway.

Mr. Clive Lord drew attention to the fact that a memorial to Tasman had recently been erected, but there existed no memorial to Furneaux, Bligh, Cook, D'Entrecasteaux, Baudin, etc., all of whom had visited Adventure Bay, and suggested that the Society might take steps in order to have a memorial erected at Adventure Bay.

Illustrated Lecture.

Dr. J. A. Leach, President of the Royal Australasian Ornithologists' Union, delivered an illustrated lecture on the Birds of Australia.

17th DECEMBER, 1923.

The Monthly Meeting of the Society was held at the Society's Rooms on Monday, 17th December, at 8 p.m., Mr. L. Rodway, C.M.G., presiding.

Mr. Lord reported that he had interviewed certain of the residents of Adventure Bay concerning the proposed memorial to the early navigators, and that the matter was under consideration.

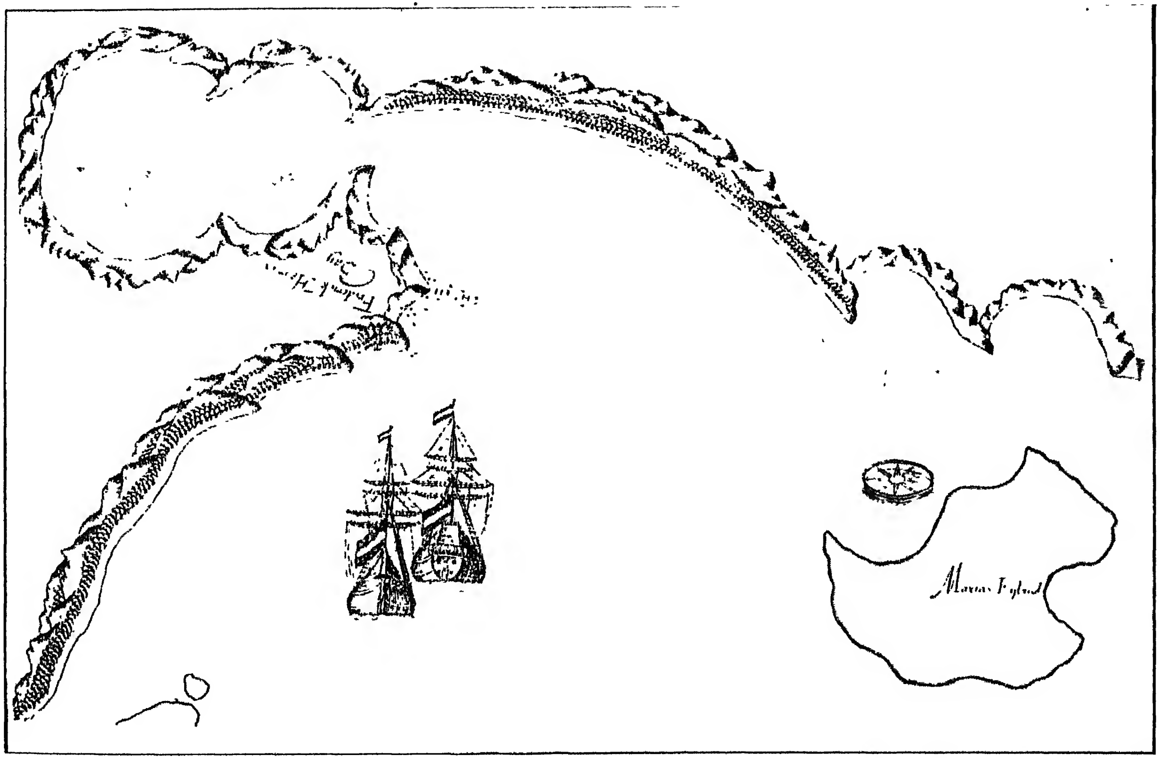
The following members were elected:—Hon. F. B. Edwards, Messrs. E. E. Unwin, M.Sc., W. H. Hudspeth, H. T. Gould, S. E. Shoobridge, Charles Davis, Alfred Davis, Rev. H. B. Atkinson, and Misses A. Wherrett, B.A., Hurst, and Agnew.

A discussion took place with regard to the site of the landing place of Tasman's Carpenter. Mr. Moore-Robinson stated that a party which included himself, Captain Bowerman, Mr. John Kennedy, and others had visited the locality in January last, and, being furnished with certain data and maps, they formed the opinion that they had found the exact spot of the landing, including the four trees mentioned by Tasman. This was at the head of the inner cove of Prince of Wales Bay.

Mr. Clive Lord referred to the fact that the position had been investigated previously, namely by Gell (1845), Walker (1889). He considered the flag was planted on the north side of the bay, as Tasman's sketch definitely showed it there, and not at the head of the inner bay. Moreover, Tasman referred to the trees being on sloping ground, and the northern side of the bay had such ground, whereas the head of the inner cove was flat. Trees could be noted on this site also if need be, but no reliance could be placed on trees. Further, Tasman would never have ventured over the reef into the inner cove.

Mr. John Kennedy questioned whether the sketch referred to by Mr. Lord had been included in Tasman's original journal. He considered that the four trees mentioned were of considerable age—one of them could easily be from 800 to 1,000 years old.

Mr. G. H. Halligan, late Government Hydrographer of New South Wales, gave reasons for his opinion that Tasman's carpenter landed in the centre of North Bay and not in



Tasman's sketch of portion of the S.E. Coast of Tasmania, showing the ships at anchor.
[From Heere's *Tasman*.]

Prince of Wales Bay. As far as the trees in Prince of Wales Bay were concerned, he was of the opinion that not one of them was 100 years old.

Mr. L. Rodway said that the trees in the locality were slow growing, the greater number would not be more than 70 years old, but there was one tree which might be a very considerable age. He considered the trees of no value at all to note the position.

Major L. F. Giblin said that the impression he got was that the problem could not be solved. He had not heard of anything which was in harmony with all the data. Possibly there were mistakes in the journal or the charts. As it stood the evidence before them was not conclusive as to the exact site of the landing.

Captain Bowerman said that Tasman's chart was not as vague as they thought. The anchor was positively shown, and the course could be followed, and any small error of bearings would not affect the result as far as the location of the bay was concerned. A detailed Admiralty chart of that section of the East Coast of Tasmania was badly needed.

Mr. John Reynolds (Honorary Secretary, Historical Section) dwelt upon the need for accuracy in historical matters and also stated his opinion that the bar across the inner cove was at any rate largely of natural formation. Mr. Reynolds moved that the Society alter the inscription on the monument from "At this spot, etc.," to "Near this spot, etc." The motion was carried.

ANNUAL REPORT
1923
The Royal Society of Tasmania

Patron:

HIS MAJESTY THE KING.

President:

HIS EXCELLENCY THE ADMINISTRATOR.

Vice-Presidents:

L. RODWAY, C.M.G.

A. H. CLARKE, M.R.C.S., L.R.C.P.

Council:

(Elected February, 1923).

L. RODWAY, C.M.G. *(Chairman)*

W. H. CLEMES, B.A., B Sc.

W. E. L. CROWTHER, D.S.O., M.B.

W. H. CUMMINS, A.I.A.C.

L. F. GIBLIN, D.S.O.

RT. REV. R. S. HAY, D.D.

J. A. JOHNSON, M.A.

J. MOORE-ROBINSON, F.R.G.S.

DR. GREGORY SPROTT, M.D., C.M.

Standing Committee:

W. H. CLEMES, L. F. GIBLIN, L. RODWAY.

Hon. Treasurer:

J. MOORE-ROBINSON, F.R.G.S.

Editor:

CLIVE LORD, F.L.S.

Auditor:

R A. BLACK.

Secretary and Librarian:

CLIVE LORD, F.L.S

LIST OF MEMBERS

Honorary Members:

David, Sir T. W. Edgeworth, K.B.E., C.M.G., B.A., F.R.S., F.G.S., Professor of Geology and Physical Geography in the University of Sydney. The University, Sydney.

Mawson, Sir Douglas, B.E., D.Sc. Adelaide.

Spencer, Sir W. Baldwin, K.C.M.G., M.A., D.Sc., Litt.D., F.R.S. Melbourne.

Ordinary, Life, and Corresponding Members:

"C," Corresponding Member.

"L," Member who has compounded subscriptions for life.

* Member who has contributed a Paper read before the Society.

† Member who has been elected a member of the Council.

Year of Election.		
1922		Adams, A. W. National Mutual Buildings, Macquarie Street, Hobart.
1921		Anderson, G. M., M.D., C.M. Clare Street, New Town.
1923		Agnew, Miss K. Augusta Road, New Town.
1921		Allen, D. V., B.Sc. Principal Launceston Technical College.
1923		Atkinson, Rev. H. B. Holy Trinity Rectory, Hobart.
1918	L	Avery, J. 52 Southerland Road, Annandale, Melbourne, Victoria.
1908	L	Baker, Henry D. C/o American Consulate, Hobart.
1921		Baker, H. S., LL.M., M.A. Stanley, Tas.
1922		Bamford, H. Commercial Bank of Australia Chambers, Elizabeth Street, Hobart.
1887		Barclay, David. 143 Hampden Road, Hobart.
1921		Barr, J. Stoddart, M.D., Glas. Lower Sandy Bay.
1890		*Beattie, J. W. 1 Mt. Stuart Road, Hobart.
1918		Bellamy, Herbert, City Engineer. Town Hall, Hobart.
1901	C	Benham, W. B., M.A., D.Sc., F.R.S., F.Z.S. Professor of Biology, University of Otago, Dunedin, N.Z.
1903		Bennett, W. H. Ashby, Ross.

Year of Election.

1921 Bertouch, V. Von. Wellington Square Practising School, Launceston.

1920 Bernacchi, A. G. D. Maria Island.

1921 Bethune, Rev. J. W., B.A. Church Grammar School, Launceston.

1921 Birchall, J. A. 118 Brisbane Street, Launceston.

1922 Biss, F. L. U.S.S. Co., Hobart.

1912 *Black, R. A. Chief Clerk, Department of Agriculture.

1909 *Blackman, A. E. Franklin.

1920 Blaikie, T. W. Practising School, Elizabeth Street, Hobart.

1918 Bowling, J. "Barrington," Tower Road, New Town.

1892 C Bragg, W. H., M.A., F.R.S. Professor of Physics in the University College, London.

1923 Breaden, J. C. 12 Waverley Avenue, New Town.

1923 Brett, R. G. 53a Hill Street, Hobart.

1917 Brettingham-Moore, E., M.B., Ch.M. Macquarie Street.

1911 Brooks, G. V. Director of Education, Education Department, Hobart.

1921 Brown, Mrs. Justin. "Waratah," York Street, Launceston.

1922 Brownell, C. C. 29 Napoleon Street, Battery Point.

1907 Brownell, F. L. "Berwyn," Mercer Street, New Town.

1921 Bruce, L. S. Tourist Bureau, Launceston.

1918 Burbury, Alfred. "Glen Morey," Antill Ponds.

1918 Burbury, Frederick. "Holly Park," Parattah.

1919 Burbury, Charles. "Brookside," Moonah.

1919 Burbury, Gerald. "Syndal," Ross.

1919 Burbury, T. J. "Park Farm," Jericho.

1922 Burrows. Major H. O. A. D. The Barracks, Hobart.

1923 Butler, Mrs. G. H. Augusta Road, New Town.

1909 †*Butler, W. F. D., B.A., M.Sc., LL.B. Bishop Street, New Town.

1921 Butler, Rev. W. Corly. The Parsonage, Melville Street.

Year of Election.		
1917		Butters, J. H. Chief Engineer and Manager State Hydro-Electric Department, Hobart.
1921		Camm, Dr. Carlyle. George Street, Launceston.
1920		Cane, F. B. 90 High Street, Sandy Bay.
1919		Chapman, A. D. Collins Street, Hobart.
1912		Chapman, J. R. Holebrook Place, Hobart.
1901	C	Chapman, R. W., M.A., B.C.E. Elder Professor of Mathematics and Mechanics in the University of Adelaide. The University, Adelaide.
1913		Chepmell, C. H. D. Clerk of Legislative Council, Hobart.
1920		Clarke, W. I., M.B. Macquarie Street, Hobart.
1896		†*Clarke, A. H.. M.R.C.S., L.R.C.P. St. Helens, Tasmania.
1918		Clarke, T. W. H. Quorn Hall, Campbell Town.
1910		†*Clemes, W. H., B.A., B.Sc. Clemes College, New Town.
1922		Collier, J. D. A. Librarian, Tasmanian Public Library.
1917		Copland, D. B., M.A. Professor of Economics. The University, Hobart.
1920		Cranstoun, Mrs. F. A. 6 Gregory Street, Sandy Bay.
1917		Cullen, Rev. John. Macquarie Street, Hobart.
1918		†Cummins, W. H., A.I.A.C. Lindisfarne.
1915		†*Crowther, W. L., M.B., D.S.O. Macquarie Street, Hobart.
1922		Davern, Miss N. St. George's Terrace.
1922		Davidson, R. Huon Timber Company, Hobart.
1919		Davies, H. Warlow, C.E. Abermere, Mt. Stuart.
1923		Davis, Alfred. Lord Street, Sandy Bay.
1923		Davis, Charles. Lindisfarne.
1908		†Dechaineux, Lucien. Principal of Technical School, Hobart.
1903		Delany, Most Rev. Patrick. Archbishop of Hobart. 99 Barrack Street.
1892	C	Dendy, A., D.Sc., F.R.S., F.L.S. Professor of Zoology in the University of London (King's College). "Vale Lodge," Hampstead, London, N.W.

Year of Election.		
1921		Douglas, O. Gordon. 27 Patterson Street, Launceston.
1921		Dryden, M. S. 13 Hillside Crescent, Launceston.
1921		Eberhard, E. C. Charles Street, Launceston.
1923		Edwards, Hon. F. B., M.L.C. Ulverstone.
1919		Elliott, E. A., M.B. Main Road, New Town.
1918		Ellis, F. Education Department, Hobart.
1921		Elms, E. A. Post Office, Launceston.
1913		Erwin, H. D., B.A. Hutchins School, Hobart.
1921		Emmett, E. T. Railway Department, Hobart.
1918		Evans, L. Acting Director of Agriculture, Hobart.
1921		Eyre, H. Manual Training School, Launceston.
1902		Finlay, W. A. 11 Secheron Road, Hobart.
1918		Fletcher, C. E. Education Department, Hobart.
1909		†*Flynn, T. T., D.Sc. Ralston Professor of Biology, University of Tasmania.
1921		Flounders, A. 102 Patterson Street, Launceston.
1921		Forward, J. R. Mechanics' Institute, Launceston.
1890	L	Foster, H., Lt.-Col. Merton Vale, Campbell Town.
1905	L	Foster, J. D. "Fairfield," Epping.
1921		Fox, Miss. Ladies' College, Launceston.
1918		Gatenby, R. L. Campbell Town.
1922		Gatenby, Miss M. 5 Berean Street, Launceston.
1923		Gibbings, R. A. C. 28 Antill Street. Hobart.
1908		†*Giblin, Major L. F., D.S.O., B.A. Government Statistician, Davey Street.
1922		Giblin, A. V. King Street, Sandy Bay.
1918		Gillett, Henry. "Wetmore," Ross.
1920		Gillies, J. H. Macquarie Street.
1923		Gorringe, J. A. Kempton, Tasmania.
1923		Gould, H. T., J.P. Liverpool Street, Hobart.
1918		Gould, J. W. Tramways Department, Hobart.
1907		Gould, Robert. Longford.
1921		Grace, W. L. 91 High Street, Launceston.
1905	L	Grant, C. W. High Peak, Huon Road.
1923		Green, Dr. A. W. 30 Parliament Street, Sandy Bay.

Year of Election.		
1923		Gunn, F. L. Davey Street, Hobart.
1921		Hall, E. L. 38 Lyttleton Street, Launceston.
1922		Halligan, G. H., F.G.S. 97 Elphin Road, Launceston.
1913		*Hardy, G. H. C/o University, Brisbane, Queensland.
1923		Harley, R. Institution for Blind, Deaf and Dumb, Hobart.
1918		Harrap, Lt.-Colonel G. Launceston.
1921		Harris, Miss Ila. Studio, Findlay's Buildings, Launceston.
1921		Harris, Dr. R. E. 73 Cameron Street, Launceston.
1921	L	Harvey, David Hastie. "Manresa," Lower Sandy Bay, Hobart.
1902	C	Haswell, William, M.A., D.Sc., F.R.S., F.L.S. The University, Sydney, N.S. Wales.
1913		Hawson, Edward. "Remine," 174 Argyle Street, Hobart.
1919		†Hay, Rt. Rev. R. S., D.D., Bishop of Tasmania. Bishopscourt, Hobart.
1921		Heritage, J. E. 76 Frederick Street, Launceston.
1921		Heyward, F., F.R.V.I.A. 43 Lyttleton Street, Launceston.
1915		Hickman, V. V., B.Sc. "Burnham," Mulgrave Crescent, Launceston.
1919		Higgins, Dr. P. Campbell Town.
1921		Hill, A. H. 143 Charles Street, Launceston.
1913		Hills, Loftus, M.B.E., D.Sc.
1914		Hitchcock, W. E. Moina, Tasmania.
1918		Hogg, G. H., M.D., C.M. 37 Brisbane Street, Launceston.
1921		Hogg, W. Public Buildings, Launceston.
1922		Hood, F. W. Customs House, Hobart.
1921		Horne, George, V.D., M.A., M.D., Ch.B. 63 Collins Street, Melbourne, Vic.
1921		Horner, A. G. 16 York Street, Launceston.
1923		Hudspeth, W. H. "The Nook," Lower Sandy Bay.
1922		Hungerford, Mrs. Red House, Fern Tree.
1922		Hungerford, Miss. Red House, Fern Tree.
1923		Hurst, Miss E. R. 39 Bay Road, New Town.

Year of Election.

1909 *Hutchison, H. R. 1 Barrack Street, Hobart.
1922 Huxley, G. H. Crescent Road, W. Hobart.
1920 Hytten, T. 338 Murray Street, Hobart.
1913 Ife, G. W. R., LL.B. Summerhill Road, Hobart.
1918 Irby, L. G. Conservator of Forests, Forestry Department, Hobart.
1898 *Ireland, E. W. J., M.B., C.M. Launceston General Hospital.
1919 Jackson, George A. 79 Collins Street, Hobart.
1906 *Johnson, J. A., M.A. Principal of Phillip Smith Training College, Hobart.
1921 Johnson, J. D. 142 St. John Street, Launceston.
1922 Johnson, W. Roye. Clemes College, New Town.
1922 Johnston, J. R. Murray Street.
1922 L Jones, Sir Henry, Kt. Campbell Street, Hobart.
1921 Judd, W., M.A. College Street, Launceston.
1921 Keating, J. H. Melbourne.
1921 Keid, H. G. W. Powelton, via Yarra Junction, Victoria.
1911 Keene, E. H. Douglas, B.A. Burnie.
1922 Kemp, Andrew. Stoke Street, New Town.
1922 Kennedy, J. St. George's Terrace, Battery Point.
1910 Kermode, R. C. Mona Vale, Ross.
1913 Knight, J. C. E. "Windermere," Claremont.
1918 Knight, C. E. L., B.Sc. Claremont.
1919 Knight, H. W. National Mutual Buildings, Macquarie Street, Hobart.
1887 †Lewis, Sir Neil Elliot, K.C.M.G., M.A., B.C.L., LL.B. "Werndee," Augusta Road, Hobart.
1919 *Lewis, A. N., M.C., LL.B. "Werndee," Augusta Road.
1912 †Lindon, L. H., M.A. "The Lodge," Park Street, Hobart.
1900 Lines, D. H. E., M.B., Ch.B. Archer Street, New Town.
1921 Listner, W. Parker, M.A., LL.B. 2 Byron Street, Sandy Bay.
1875 C Liversidge, Professor Archibald, M.A., LL.D., A.R.S.M., F.R.S., F.I.C., F.C.S., F.G.S., F.R.G.S. "Fieldhead," Coombe Warren, Kingston, Surrey, England.

Year of Election.		
1912		†*Lord, Clive E., F.L.S. Director of the Tasmanian Museum, Hobart. "Cliveden," Sandy Bay.
1921		Lord, Chester. "Mellifont," High Street, Sandy Bay.
1921		Lord, Raymond. "Handroyd," 6 Franklin Street, Hobart.
1922		Lowe, H. M. Hadley's Hotel, Murray Street, Hobart.
1922		Macleod, Mrs. L. H. High Street, Sandy Bay.
1919		Mackay, A. D., B.Sc., M.M.E. 4 Fawkner Street, South Yarra, Vic.
1912		McAlister, Miss M. K. Holebrook Flats, Holebrook Place.
1893		*McAulay, Alexander, M.A., Professor Mathematics in the University of Tasmania. The University, Hobart.
1923		McAulay, A. L., Ph. D. The University, Hobart.
1921		McGowan, W. Superintendent of Reserves, Launceston.
1921		McClinton, Dr. R. 70 St. John Street, Launceston.
1921		McInytre, Dr. W. Keverall. 37 Brisbane Street, Launceston.
1902	C	*Maiden, J. H., I.S.O., F.R.S., F.L.S., Director of the Botanic Gardens, Sydney, & Government Botanist of N.S.W. Botanic Gardens, Sydney.
1918		Mansell, A. E. Melton Mowbray.
1918		Martin, Brig.-General W., V.D. Launceston.
1913		Mather, J. F. 15 Church Street, Hobart.
1921		Masters, A. H. A.M.P. Chambers, Launceston.
1895		*May, W. L. Forest Hill, Sandford.
1909		Millen, Senator J. D. Roxburgh, Newstead.
1907		Miller, Lindsay S., M.B., Ch.B. 156 Macquarie Street, Hobart.
1921		Miller, W., c/o D. & W. Murray Ltd., Launceston.
1921		Miller, R. M. State High School, Launceston.
1894	L	Mitchell, J. G. Parliament Street, Sandy Bay.
1911		Montgomery, R. B. "Astor," Macquarie Street, Hobart.

Year of Election.		
1921		Morris, E. Sydney, M.B., Ch.M., D.P.H., Chief Health Officer, Tasmania. 3 Montague Avenue, New Town.
1918		Murdoch, Hon. Thomas, M.L.C. 55 Montpelier Road, Hobart.
1921		Murdoch, Ronald. "Marathon," Lower Sandy Bay.
1921		Muschamp, Rev. E. Holy Trinity Rectory, Launceston.
1882		Nicholas, G. C. "Cawood," Ouse.
1918		Nicholls, Sir Herbert, Kt., Chief Justice of Tasmania. Pillinger Street, Queenborough.
1910		Nicholls, H. Minchin, Government Microbiologist, Dept. of Agriculture, Hobart. Macquarie Street, Hobart.
1921		Nye, P. B. Geological Survey Office. Hobart.
1917		Oldham, N., J.P. New Town.
1921		Oldham, W. C. 39 George Street, Launceston.
1922		Overell, Miss Lilian. Holebrook Place.
1921		Padman, R. S. 56 St. John Street, Launceston
1921		Patten, W. H. 59 Cameron Street, Launceston.
1923		Parker, Dr. G. M. Swansea, Tasmania.
1922		Parker, H. T. Training College, Hobart.
1921		Parker, R. L. 81 St. John Street, Launceston.
1908		Parsons, Cecil J. 190 Davey Street, Hobart.
1888	C	Pearson, W. H., M.Sc., A.L.S. 18 Palatine Road, Withington, Manchester, Eng.
1923		Pedder, A. Stoke Street, New Town.
1922		Perrin, Miss K. 16 York Street, Launceston.
1902		†*Piesse, E. L., B.Sc., LL.B. "Merridale," Sackville Street, Kew, Melbourne.
1910		Pillinger, James. 4 Fitzroy Crescent, Hobart.
1918		Pitt, Frank C. K. "Glen Dhu," The Ouse.
1919		Pitt, C. F. Campbell Town.
1908		Pratt, A. W. Courtney. "Athon," Mt. Stuart Road, Hobart.
1922		Pulleine, R., M.B. 163 North Terrace, Adelaide.
1923		Purcell, G. A. Clemes College, Hobart.
1922		Reid, A. R. Curator, Beaumaris Zoo, Domain, Hobart.

Year of Election.		
1921		Reid, A. McIntosh. Geological Survey Office, Hobart.
1921		Reid, W. D. Public Buildings, Launceston.
1921		Reynolds, John. Knocklofty Terrace, Hobart.
1919		Riggall, Captain A. Hortin, D.S.O. Tunbridge.
1912		†*Robinson, J. Moore-. Librarian and Publicity Officer, Chief Secretary's Department, Hobart.
1884		†*Rodway, L., C.M.G., Government Botanist. 77 Federal Street, Hobart.
1923		Rogers, G. H. B., M.A. Royal Exchange Chambers, Collins Street, Hobart.
1921		Rolph, W. R. *Examiner* & *Weekly Courier* Office, Launceston.
1913		Ross, Hector. Cambridge.
1922		Sargison, H. Elizabeth Street, Hobart.
1921		Savigny, J. 21 York Street, Launceston.
1896		Scott, R. G., M.B., Ch.M. 172 Macquarie Street, Hobart.
1921		*Scott, H. H. Curator of the Victoria Museum, Launceston, Tas.
1921		Sharland, M. S. R. C/o *The Mercury* Office, Hobart.
1892	C	*Shirley, John, D.Sc., Principal Teachers' Training College, Queensland. "Cootha," Bowen Hills, Brisbane.
1921		Shields, Hon. Tasman, M.L.C. 13 Patterson Street, Launceston.
1901		Shoobridge, Canon G. W. 3 Molle Street, Hobart.
1921		Shoobridge, Hon. L. M., M.L.C. "Sunnyside," New Town.
1923		Shoobridge, S. E. c/o Messrs. H. Jones and Co., Ltd., Hobart.
1923		Simson, Mrs. L. 3 St. George's Square, Launceston.
1917		Slaytor, C. H., F.I.C. Misterton, Doncaster, England.
1901	C	Smith, R. Greig, D.Sc. Linnean Hall, Elizabeth Bay, Sydney.
1921		Smithies, F. 34 Patterson Street, Launceston.
1919		Snowden, Colonel R. E. "Minallo," West Hobart.

Year of Election.

1896 L *Sprott, Gregory, M.D., C.M. Macquarie Street, Hobart.

1921 Spurling, S., Jnr. Brisbane Street, Launceston.

1919 Stevenson, Miss F. "Leith House," New Town.

1920 Swindells, A. W. 141 Campbell Street.

1907 Tarleton, J. W. Sandy Bay.

1918 Taylor, Walter E. Elboden Street, Hobart.

1920 Taylour, W. H. Equitable Buildings, Melbourne.

1920 Taylour, Harold. Equitable Building, Melbourne.

1922 Thomas, Lt.-Colonel L. R., D.S.O. Registrar of the University of Tasmania.

1921 Thomas, P. H. Agricultural Department, Hobart.

1922 Thomson, E. H. Lower Sandy Bay.

1892 C *Thompson, G. M., F.L.S. Dunedin, N.Z.

1918 †Thorold, C. C., M.A. The Hutchins School, Hobart.

1921 Tymms, Dr. A. O. 18 York Street, Launceston.

1923 Unwin, E. E., M.Sc. Friends' High School, Hobart.

1921 Wakefield, F W

1918 Walch, Percy. King Street, Sandy Bay.

1901 C Wall, Arnold, M.A. Professor of English Language & Literature in Canterbury College, Christchurch, N.Z.

1913 Wardman, John. Superintendent of the Botanical Gardens, Hobart.

1918 Waterhouse, G. W., B.A., LL.M., Cantab. Messrs. Ritchie & Parker, Alfred Green & Co., Launceston.

1922 Waterworth, E. N. Poet's Road, W. Hobart.

1922 Watson, D. W. Hobart.

1922 Wayn, Miss A. L. Lambert Avenue.

1918 Weber, A. F. Lands Department, Hobart.

1923 Webster, Hugh C. "Greystanes," Lower Sandy Bay.

1923 Wherrett, Miss A., B.A. Florence Street, Moonah.

1920 Williams, Hon. W. M., O.B.E. Augusta Road, Hobart.

1922 Winch. A. A. Huon Road.

1901 Wise. H. J. Lambert Avenue, Sandy Bay.

1921 Wright, W. Invermay State School, Launceston.

ANNUAL REPORT

1923

The Council and Officers.

The Annual Meeting was held at the Society's Rooms, the Tasmanian Museum, on Monday, 26th February, 1923. The following members were elected as the Council for 1923:—Messrs. W. H. Clemes, W. H. Cummins, Dr. W. L. Crowther, Major L. F. Giblin, Rt. Rev. Dr. R. S. Hay, Messrs. J. A. Johnson, J. Moore-Robinson, L. Rodway, and Dr. Sprott.

During the year 12 meetings of the Council were held, and the attendance was as follows:—Dr. Crowther 11, Mr. Rodway 10, Mr. Johnson 9, Mr. Clemes 8, Mr. Moore-Robinson 8, Major Giblin 6, Dr. Sprott 6, Rt. Rev. Dr. Hay 3, Mr. Cummins nil (on leave of absence during part of the year on account of ill health).

The Council at its first meeting made the following appointments:—

Chairman of Council: Mr. L. Rodway, C.M.G.

Standing Committee: Messrs. Rodway, Clemes, and Major Giblin.

Editor of Papers and Proceedings: Mr. Clive Lord

Honorary Treasurer: Mr. J. Moore-Robinson.

Trustees of the Tasmanian Museum and Botanical Gardens: Doctors Crowther and Sprott, Messrs. Clemes, Cummins, Johnson, and Rodway.

Meetings.

During the year ten ordinary meetings of the Society were held, and were well attended. Outlines of the papers read and the lectures delivered will be found in the Abstract of Proceedings.

Membership.

The membership of the Society continues to be satisfactory, and the roll at the end of the year showed three Honorary Members, 12 Corresponding Members, 9 Life Members, and 245 Ordinary Members.

Finance.

The financial position of the Society has received careful consideration throughout the year. Unfortunately, it was not possible to obtain additional assistance from the Government.

Papers and Proceedings.

The Volume of the Papers and Proceedings for the year will be found to compare favourably with previous years, but financial considerations have made it necessary to refuse or postpone papers which would otherwise have been included.

R. M. Johnston Memorial.

The first R. M. Johnston Memorial lecture was delivered by Professor Sir T. W. Edgeworth David on Monday, 8th October; a full report appears in the Papers published for the year.

Tasman Memorial.

At the Annual Meeting of the Society held on 8th March, 1920, Sir Herbert Nicholls drew attention to the need for a memorial to commemorate the visit of Tasman in 1642. At a meeting of the Historical Section held on 26th October, Mr. Lord drew attention to the matter, with the result that the matter was taken up by the Section. The investigations of the Historical Section, however, were not finalised owing to the fact that Mr. J. Moore-Robinson and Mr. John Kennedy arranged a private visit to the site, and made a report direct to the Council of the Society. Acting upon this report the Council authorised the erection of a memorial on the site selected by this expedition. The exact position chosen by this expedition as being in their opinion the landing place of Tasman's carpenter is at the extreme head of the inner cove of Prince of Wales Bay. Later, the Historical Section again took the matter up as reported in the Abstract of Proceedings, 17th December, 1923. The memorial was erected during October by a party acting under the direction of Mr. John Kennedy, and was formally unveiled by Sir Herbert Nicholls on 3rd December. The erection of the memorial was made possible owing to the subscriptions received from members of the Society and others interested.

Obituary.

It is with regret that the Society has to record the death of the following members during the year:—

T. P. Arnold, Hobart, elected a member in 1920.

R. W. Canning, Hobart, elected a member in 1920.

N. Nicolson, Campbell Town, elected a member in 1919.

Miss S. R. Parsons, Hobart, elected a member in 1908.

P. S. Seager, I.S.O., Hobart, elected a member in 1922.

L. Simpson, Launceston, elected a member in 1921.

Dr. L. Grey Thompson, Launceston, elected a member in 1921.

Sir Herbert Nicholls unveiling the Tasman Memorial.

BRANCH REPORTS

NORTHERN BRANCH.

ANNUAL REPORT FOR THE YEAR 1923.

In these days of financial stress, and more or less unstable social conditions, it is satisfactory to be able to report that a scientific society is at least holding its own, and is on firm ground, with room for optimism as regards its future prospects. The Northern Branch has, unfortunately, lost one of its most valuable members in Dr. L. Grey Thompson, who died at Launceston on the 24th of October of this year. His unselfish devotion to the cause of science, and to the advancement of his fellow men, combined with his genial nature and broad outlook, endeared him to all, and his place will not be readily filled. One member has retired owing to absence from the State, and two new members have been elected.

On the 20th of June the following committee was elected:—Chairman, the Honourable Tasman Shields; members, Messrs. H. H. Scott, J. E. Heritage, R. O. M. Miller, F. Smithies, J. R. Forward, W. D. Reid, F. J. Heyward, and G. H. Halligan, L.S., F.G.S., Honorary Secretary and Treasurer.

Four papers were read, and two lectures delivered during the session, as follows:—

31st May—Lecture by Mr. Clive E. Lord, F.L.S., Director of the Tasmanian Museum, on "The Economic Aspects of the Tasmanian Fauna."

12th July—Paper by Mr. G. W. Waterhouse on "The Settlement of the North-West Coast of Tasmania by the Van Diemen's Land Co."

25th July—Paper by Mr. H. H. Scott on "Additional Notes on the Emus of King Island and Tasmania."

28th August—Paper by Mr. L. Rodway, C.M.G., Government Botanist, on "Plant Pathology, with special reference to Fungus Diseases."

15th October—Lecture by Mr. G. H. Halligan, L.S., F.G.S., on "The Doings of the Recent Pan-Pacific Congress at Melbourne and Sydney."

12th November—Paper by Mr. W. H. Reid, A.I.M.M., Lond., A.C.I., Aust., on "Notes on Sampling and the Utilisation of Coal in the Pulverised Form."

REPORTS OF SECTIONS

HISTORICAL AND GEOGRAPHICAL SECTION.

1. *Meetings.*

The Annual Meeting of the Historical Section of the Royal Society was held on 21st June. The resignation of Mr. J. Moore-Robinson from the position of Honorary Secretary was accepted, and Mr. J. Reynolds was elected to the position. It was decided to hold only three more meetings at monthly intervals if possible during the remaining part of the year. The dilapidated state of Old St. David's Burial Ground was brought before the notice of members, and it was decided that the section should actively interest itself in a scheme for preservation. The meeting concluded with an inspection of original sketches of early Tasmania in possession of the Royal Society.

The second meeting of the Section was held on 19th July, 1923. The chief business was the discussion of the measures the section should take regarding the preservation of Old St. David's Burial Ground. A short lecture entitled "The Genesis of Industry in Tasmania," illustrated with lantern slides, was given by Mr. J. Reynolds.

The third meeting was held on 22nd August, and the entire evening was devoted to discussing practical measures for the preservation of Old St. David's Burial Ground. Representatives of the Church authorities and other gentlemen actively interested were present. After discussion two motions were carried. The first, that the Church authorities be requested to confer with the City Council regarding a scheme for preservation, the Historical Section lending them all assistance possible. The second motion embodied the details of a scheme for the City Council to consider, in which it was proposed to reserve only a small area of the Burial Ground and therein suitably arrange all monuments of historic interest.

The last meeting was held on 15th November. A considerable amount of important business was brought before the meeting, including the position of the Tasman memorial, the proposed erection of a memorial to early navigators at Adventure Bay, the commemoration of centenary of constitutional separation from N.S. Wales, and the status of the section. At the termination of the business Mr. W. F. D. Butler read a paper on the Lady Franklin Museum and the Ancanthe estate.

2. *General Remarks on the Activities of the Section.*

1. Old St. David's Burial Ground.—The preservation of monuments of historical interest in this burial ground has greatly interested the Section this year, the chief aim being to raise public opinion in favour of the adoption of some definite and fitting scheme in the near future.

2. Historical Monuments.—Owing to the selection of the site for the Tasman memorial being taken out of its hands, the Section felt that it could not assume any responsibility for the accuracy of the determination of the present site. At the November meeting, the Section, after considering the position and recognising that no small amount of doubt existed, passed a motion recommending that the Council of the Royal Society change the wording on the Memorial from "At this spot" to 'Near this spot." The Section has also interested itself in the proposed erection of one memorial to all the navigators who visited Adventure Bay between 1772 and 1802.

3. Historical Research.—Realising the necessity of making a definite advance in research work and the necessity of establishing its own bureau of information, the Section have voted a small sum of money for the purpose of putting a reference card index system into operation. The importance of collecting historical reference cannot be overestimated, and it is hoped that in the not distant future the Section will possess a both extensive and valuable reference system.

EDUCATIONAL SECTION.

Chairman: T. W. Blaikie.
Secretary: H. T. Parker.

The following meetings were held:—

24th April—Observations made in the Schools and Colleges of New Zealand. Mr. J. A. Johnson.

15th May.—A Historical Résumé of the Development of Educational Measurement. Mr. Parker.

12th June.—Intelligence: Its Measurement and Distribution. Mr. Huxley.

10th July.—Comprehension and Interest as Related to the School Curriculum. Mr. Fletcher.

14th August.—Tests of Scholastic Efficiency: Measurement of the Products of Instruction. Messrs. Johnson and Dechaineux.

11th September.—Rote Learning: Its Place in the Curriculum. Messrs. Clemes and Purcell.

ROYAL SOCIETY OF TASMANIA.

RECEIPTS AND EXPENDITURE, 1923. GENERAL FUND.

RECEIPTS.

	£	s.	d.
Balance brought forward	1	13	6
Government Grant in Aid	100	0	0
Subscriptions, &c.	231	0	0
Sundries	2	5	11
	£334	19	5

PAYMENTS.

		£	s.	d.
Light and Fuel		1	18	0
Postage and Petty Cash		17	15	5
Salaries		32	10	0
Papers and Proceedings:—				
1922	£72 17 10			
1923	73 3 4			
		146	1	2
Expenses of Meetings, &c.		63	9	8
Refund Northern Branch		15	15	0
Library and Insurance		53	15	1
Lantern Operator		2	14	6
Cheque Book		0	5	0
		334	3	4
Credit Balance		0	16	1
		£334	19	5

I have compared the Receipt Book, Vouchers, and Bank Book with items particularised in the Cash Book, and found them to be correct.

R. A. BLACK,
Hon. Auditor.

23/2/24.

J. MOORE ROBINSON,
Hon. Treasurer.

22/2/24.

R. M. JOHNSTON MEMORIAL FUND, 1923.

RECEIPTS.	£	s.	d.	PAYMENTS.	£	s.	d.
From last balance	13	5	0	By Purchase Memorial Medals	26	6	2
Revenue 1923-24	14	12	0	Credit Balance	1	10	10
	£27	17	0		£27	17	0

MORTON ALLPORT MEMORIAL FUND, 1923.

RECEIPTS.	£	s.	d.	PAYMENTS.	£	s.	d.
From last balance	9	15	0	To Purchase of Books	15	12	0
Revenue 1923-24	9	15	0	Credit Balance	3	18	0
	£19	10	0		£19	10	0

THE ROYAL SOCIETY OF TASMANIA, NORTHERN BRANCH.

STATEMENT OF RECEIPTS AND EXPENDITURE, 31st DECEMBER, 1923.

	£	s.	d		£	s.	d.
To Balance from last Account	12	13	4	By Advertisements and Printing, &c.	4	19	5
„ Subscriptions received	15	15	0	„ Lantern Hire	0	17	0
„ Interest	0	8	2	„ Travelling Expenses	2	0	0
				Balance	21	0	1
	£28	16	6		£28	16	6

Audited and found correct,
J. E. HERITAGE,
Hon. Auditor.

GERALD H. HALLIGAN,
Hon. Secretary and Treasurer.

INDEX

Titles of Papers, and New Genera and Species in **Heavy Type.**

THE ROYAL SOCIETY
OF
TASMANIA

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1924

(With 22 Plates and 26 Text Figures)

ISSUED 2nd MARCH, 1925

PUBLISHED BY THE SOCIETY

The Tasmanian Museum, Argyle Street, Hobart
1925

Price : Ten Shillings

The responsibility of the statements and opinions in the following papers and discussions rests with the individual authors and speakers; the Society merely places them on record.

THE ROYAL SOCIETY OF TASMANIA

The Royal Society of Tasmania was founded on the 14th October, 1843, by His Excellency Sir John Eardley Eardley Wilmot, Lieutenant Governor of Van Diemen's Land, as "The Botanical and Horticultural Society of Van Diemen's Land." The Botanical Gardens in the Queen's Domain, near Hobart, were shortly afterwards placed under its management, and a grant of £400 a year towards their maintenance was made by the Government. In 1844, His Excellency announced to the Society that Her Majesty the Queen had signified her consent to become its patron; and that its designation should thenceforward be "The Royal Society of Van Diemen's Land for Horticulture, Botany, and the Advancement of Science."

In 1848 the Society established the Tasmanian Museum; and in 1849 it commenced the publication of its "Papers and Proceedings."

In 1854 the Legislative Council of Tasmania by "The Royal Society Act" made provision for vesting the property of the Society in trustees, and for other matters connected with the management of its affairs.

In 1855 the name of the Colony was changed to Tasmania, and the Society then became "The Royal Society of Tasmania for Horticulture, Botany, and the Advancement of Science."

In 1860 a piece of ground at the corner of Argyle and Macquarie streets, Hobart, was given by the Crown to the Society as a site for a Museum, and a grant of £3,000 was made for the erection of a building. The Society contributed £1,800 towards the cost, and the new Museum was finished in 1862.

In 1885 the Society gave back to the Crown the Botanical Gardens and the Museum, which, with the collections of the Museum, were vested in a body of trustees, of whom six are chosen from the Society. In consideration of the services it had rendered in the promotion of science, and in the formation and management of the Museum and Gardens, the right was reserved to the Society to have exclusive possession of sufficient and convenient rooms in the Museum, for the safe custody of its Library, and for its meetings, and for all other purposes connected with it.

In 1911 the Parliament of Tasmania, by "The Royal Society Act, 1911," created the Society a body corporate by the name of "The Royal Society of Tasmania," with perpetual succession.

The object of the Society is declared by its Rules to be "the advancement of knowledge."

His Majesty the King is Patron of the Society; and His Excellency the Governor of Tasmania is President.

THE ROYAL SOCIETY OF TASMANIA

PAPERS AND PROCEEDINGS, 1924

CONTENTS

PAPERS

OF THE

ROYAL SOCIETY OF TASMANIA

1924

EAR BONES OF *NOTOTHERIA* AND ALLIED ANIMALS.

By

H. H. SCOTT, Curator of Launceston Museum,

and

CLIVE E. LORD, F.L.S., Director of Tasmanian Museum, Hobart.

(Read 14th April, 1924.)

If we pass in review the osteology of the ear bones of the Kangaroo, the Wombat, the Native Bear, etc. and then turn to the *Nototheria*, we get an interesting series of departures from a common type, which latter we may assume began by manifesting a fairly normal development of the bones, in the region of the ear. Just what that ancient type was need not at present detain us, our work being rather that of showing how the bones have developed, dwindled, coalesced, and otherwise altered, as the several groups of marsupials, above named, followed their special lines of evolution. In so doing, are we to regard each group as being a law unto itself expressed, once and for all, or did the several changes become analogues of those passed through by other creatures (not of necessity marsupial) in other parts of the world? Although perfectly aware of the fact that this subject is not popular with modern biologists, we think that work along these lines is worth attempting, and will eventually be found useful.

THE POSTULATED ANCESTOR.

It cannot be too much to assume that in the hypothetical type the following characters duly obtained:—

1. That the par-occipital bounded the occiput.

2. The mastoid portion of the periotic was wedged between the par-occipital and the post-tympanic.

3. That the post-tympanic was well developed.

4. That the tympanic was a bony ring, at the surface of the skull, if anything nearer to the post-tympanic than to the post-glenoid.

5. That the post-glenoid was a well-marked process.

KANGAROO.

1. The par-occipital is a long and well developed process, but does not strictly bound the occiput, the shorter, truncated mastoid forming the outward cranial extension.

2. The mastoid strip is in evidence.

3. The post-tympanic has coalesced with the mastoid element, but its tympanic over-arch can still be seen.

4. The bony ring of the tympanic occupies the centre of the otocrane, and reaches backward and forward, by solid extensions of its bony substance.

5. The post-glenoid is short and stout, and is slightly embraced by the tympanic, and that to a greater or a lesser extent in individual skulls.

From the hypothetical type, then, we here note the following departures, being the sum total of the evolution of the external (bony) ear of the Kangaroo:—

1. The par-occipital has grown in thickness, by the addition of a moiety (upon its inner side) from the mastoid, so that it now forms the inner half of the process.

2. The mastoid has bounded the skull by a truncated process.

3. The post-tympanic has retained its original characters, more mesiad than distad.

4. The tympanic has grown, to compensate for the reduction of the post-tympanic, and most likely altered its direction.

5. Owing to the changes just noted, the post-glenoid has become more directly associated with the tympanic.

THE TASMANIAN WOMBAT.

In this marsupial we may observe:—

1. The par-occipital has been forced mesiad, and does not, by a long way, bound the occiput.

2. The mastoid forms a mastoid process, actually bounding the skull.

3. The post-tympanic is in-stepped, and forms the median boundary wall of the occiput, and is thin and knife-edged in structure.

4. The tympanic surrounds, without touching, the post-glenoid, but is more closely associated with the post-tympanic. In young animals, however, it is central, showing that the change of direction is relatively recent.

5. The post-glenoid is a well-marked process, but excavated by air cells.

The changes thus manifested show that in its evolution the wombat has:—

1. Dwarfed the par-occipital, and driven it mesiad.

2 & 3. Produced the mastoid and post-tympanic.

4. Altered the tympanic to meet the condition of enlargement (by means of air cells) of the whole region of the ear.

5. Retained, but re-adapted, the post-glenoid.

The needs that stimulated these changes were met in a somewhat different way in the Hairy-nosed Wombat of South Australia. in which animal the tympanic has retained its central position, by throwing out extensions to meet the post-tympanic, and the post-glenoid. The latter process has dwarfed to the merest semblance of its former greatness, the enlarged tympanic, and the enormous air cells being, at present, the chief features of the ear.

These changes in Wombats amount to as much or indeed rather more variation from the assumed type as we found among Kangaroos.

THE NATIVE BEAR.

1. The par-occipital bounds the occiput, and is a direct outgrowth from the ex-occipital, receiving nothing from the mastoid.

2. The mastoid unites with the post-tympanic in a knife-edged upper bounding wall.

3. The post-tympanic strongly over-arches the tympanic.

4. The tympanic is a slightly marked tube recessed into the central portion of the bony ear.

5. The post-glenoid is large and dilated by air cells intc an extensive chamber easily half the size of the true bulla—which latter is enormous.

Comparison with the hypothetical type (6) will show the following retentions and variations:—

1. The par-occipital must be almost, if not quite, a replica of the type.

2. The mastoid has also varied little.

3. The post-tympanic strongly over-arches the ear, and retains much of its original importance.

4. The tympanic ring has dwarfed, and become recessed, but still retains its central position. It embraces the post-glenoid, and presents a surface to the post-tympanic and mastoid.

5. The post-glenoid is large, and dilated extensively by air cells, forming, in fact, a chamber half the size of the enormous bulla (as already said), the whole of which are departures from the type.

THE TASMANIAN PHALANGER.

1. The par-occipital is removed mesiad.

2. The mastoid, which bounds the occiput, is to all intents and purposes a large air chamber. Ventrad it extends to and coalesces with the true bulla, and the tympanic, as well as with the par-occipital.

3. The post-tympanic is also a large air chamber extending without a break across to the squamosal portion of the zygoma.

4. The tympanic has coalesced with the surrounding bony elements of the ear, a slight notch alone indicating its separation from the post-tympanic.

5. The post-glenoid is well defined forward, but backward is ankylosed to the edge of the tympanic ring, which latter is very thin.

In Cook's Phalanger the variations are as follows:—

1. The par-occipital is long, as in the assumed type, but does not quite bound the occiput.

2. The mastoid extends well up the skull, and early coalesces with the other bony moieties of the ear.

3. The post-tympanic is not separate from the other squamosal elements, but unites with them to bound extensive air chambers.

4. The tympanic is more ring-like, and stands out farther, than that of the other phalanger.

5. The post-glenoid is thin, and has coalesced with the tympanic; in fact, the whole area is a mass of air cells, through which the tympanic ring penetrates.

Having thus passed in review the several expansions, contractions, and suppressions of the bones of the ears of those marsupials that chiefly interest us in our quest, we can see that every important change of life they were called upon to meet wrote a well-defined record upon their otocranes.

Wombats, adapting themselves to a fossoral life, altered the whole character of the ear in some such way as that noted above, while the hairy-nosed race developed specific variations from the generic variant. What is true of the wombats is true of the whole group just passed in review, and, accordingly, when we come to deal with the *Nototheria* we may reasonably expect to encounter similar changes, and once having found them, to use them, if so required, for taxonomic purposes.

NOTOTHERIUM MITCHELLI.

If we had to change the ear of any existing Tasmanian marsupial into one similar to that of *Nototherium mitchelli*, the ear most easy of such a conversion would be that of *Trichosurus vulpecula*. To accomplish the change it would only be necessary to bend forward the mastoid process, and ankylose it to the post-glenoid. As already pointed out (P. and P. Roy. Soc. Tas., 1920, page 108), our studies led us to conclude that the ear of *N. mitchelli* had been formed by an equal blending of the post-glenoid, post-tympanic, and mastoid processes, together with a coalescing of the tympanic ring, until the whole represented a solid bony mass, and these extended researches among allied marsupials (that

show changes rung upon every moiety of the bony ear) render this statement as feasible to-day as it was then The absence of a series of immature skulls of the giant marsupial render it at present impossible to absolutely check the steps in this evolutionary process, but as we said in our paper *(loc. cit.)*, the ear of *Nototherium tasmanicum* was a stage nearer the primitive condition, as will now be duly shown.

NOTOTHERIUM TASMANICUM.

Not being called upon to thicken up the skull to support a fighting weapon of appreciable size, this creature shows specific differences about equal to those that obtain between the common mainland wombat and that of the hairy-nosed form of South Australia.

All the elements of the bony ear can be traced, and their several dispositions are as follows:—

1. The post-glenoid has bent backwards, and fuzed with the post-tympanic.

2. The tympanic ring can still be traced.

3. The post-tympanic has coalesced with the post-glenoid, their union forming (distad) a bony process.

4. The mastoid still shows as a blunt process—it and ex-occipital bound the occiput.

5. The par-occipital, which is a massive process, is removed mesiad some 50 mm.

This amount of variation, between the two animals named, is great, as is usually found among specifically distinct marsupials.

And now let us re-ask the question: Do these changes among marsupials agree at all with those found among their non-marsupial analogues? Let us see.

DINOCERAS MIRABILE (MARSH).

In this animal the following conditions obtained:—

1. The par-occipital was dwarfed.

2. The mastoid strip of the periotic appeared upon the surface.

3. The post-tympanic was large, and bounded the auditory meatus.

4. The tympanic was recessed, and seemingly was more foraminal than tube-like.

5. The post-glenoid was a large and powerful process. In *Dinoceras laticeps*, there is a marked tendency to blend the ear bones into a solid mass.

In *Tinoceros ingens* (of Marsh) everything posterior to the auditory meatus is fused into a bony unit, a condition that apparently supervened upon the evolution of the fighting bosses. These several studies teach us that with the incoming of fighting habits, the variations of the otocrane are markedly similar, be the animal a more or less Tapir-like Marsupial, evolving weapons of offence, a Titanothere, or an ungulate, destined to become a true Rhinoceros. If we carefully weigh up the possibilities, however, that present themselves to us, as the results of any such sequence as that we have been dealing with, the conviction grows that mere environmental stress will not account for all the conditions met with. In other words, we think that evolving races of animals follow a more or less orderly sequence, plus, and minus, local conditions, for one of which biological factors we used the term "Rhinoceros Trend" in our former papers to this Society. The hasty rejection, by early evolutionists, of the law of "correlated modifications" was an unwise step, for what was really wanted was a wider and more literal use of it, rather than its elimination as a mere superficiality.

"Parallel Evolution," and similar terms, are shorn of much of their force if nothing exists behind them, as a *vera causa*, but environmental pressure. The few notes here presented are but a portion of a much larger collection made by us, including a comparative series from the existing ungulates, but space forbids their inclusion into the present text. We might also have followed out the ratios of environmental effect upon the otocranes of the marsupials named, with a view to estimating the amount of the unaccounted for balance, had conditions of publication so favoured us.

LITERATURE.

1884 Monograph of the *Dinocerata*, U.S. Geol. Survey, Vol. X., 1884, by Prof. O. C. Marsh.

1920 Studies in Tasmanian Mammals, living and extinct, P. and P. Roy. Soc. Tas., by Scott and Lord.

TWO INTERESTING FUNGI.

By

L. RODWAY, C.M.G., Government Botanist.

(Read 14th April, 1924.)

In June, 1902. I sent an underground fungus to Kew to be named, and with the hope that a description would be published in due course in the Kew Bulletin. George Massee, who at that time controlled the fungus department, suggested for it the name *Secotium sessile*, but it appears a description was not published.

In the year 1911 I read a paper before the Royal Society of Tasmania on the *Hymenogastraceæ* of Tasmania, including therein four *Secotiums*. In all good faith I described *S. sessile*, believing it had already been described by Massee. Mr. G. H. Cunningham, Mycologist of New Zealand, now points out that, according to modern ideas, the presence of Cystidia places this tuber in the genus *Elasmomyces*, and advises me to describe it as a member of that genus.

Elasmomyces sessile, n.n.—Subterranean, then emerging at maturity, subglobose, 3-4 cm. diameter, white, then pale red on exposure; stem-like base well developed, piercing to the middle or sometimes to the apex of the tuber. Peridium very thin, papery. Gleba white, becoming cream-coloured, canals very contorted, the tramal plates mostly radiating from the sterile column, sometimes very like contorted gills. Cystidia numerous, fusiform, 40-50 μ. long. Spores globose, minutely echinulate, hyaline, 9 μ. diameter.

Gathered on the lower slopes of Mt. Wellington and Mt. Field. Rare.

Æcidium celmisium, n.s.—Æcidia irregularly clustered on the external surface of the leaf. Peridium white, much exserted and torn. Spores irregularly oblong, hyaline minutely but closely verruculose, 40-50 x 30 μ.

On leaves of *Celmisia longifolia* at Collins' Bonnet. Altitude, 4,000ft.

PAPERS

OF THE

ROYAL SOCIETY OF TASMANIA

1924

EAR BONES OF *NOTOTHERIA* AND ALLIED ANIMALS.

By

H. H. Scott, Curator of Launceston Museum,

and

Clive E. Lord, F.L.S., Director of Tasmanian Museum. Hobart.

(Read 14th April, 1924.)

If we pass in review the osteology of the ear bones of the Kangaroo, the Wombat, the Native Bear, etc. and then turn to the *Nototheria,* we get an interesting series of departures from a common type, which latter we may assume began by manifesting a fairly normal development of the bones, in the region of the ear. Just what that ancient type was need not at present detain us, our work being rather that of showing how the bones have developed, dwindled, coalesced, and otherwise altered, as the several groups of marsupials, above named, followed their special lines of evolution. In so doing, are we to regard each group as being a law unto itself expressed, once and for all, or did the several changes become analogues of those passed through by other creatures (not of necessity marsupial) in other parts of the world? Although perfectly aware of the fact that this subject is not popular with modern biologists, we think that work along these lines is worth attempting, and will eventually be found useful.

THE POSTULATED ANCESTOR.

It cannot be too much to assume that in the hypothetical type the following characters duly obtained:—

1. That the par-occipital bounded the occiput.

2. The mastoid portion of the periotic was wedged between the par-occipital and the post-tympanic.

3. That the post-tympanic was well developed.

4. That the tympanic was a bony ring, at the surface of the skull, if anything nearer to the post-tympanic than to the post-glenoid.

5. That the post-glenoid was a well-marked process.

KANGAROO.

1. The par-occipital is a long and well developed process, but does not strictly bound the occiput, the shorter, truncated mastoid forming the outward cranial extension.

2. The mastoid strip is in evidence.

3. The post-tympanic has coalesced with the mastoid element, but its tympanic over-arch can still be seen.

4. The bony ring of the tympanic occupies the centre of the otocrane, and reaches backward and forward, by solid extensions of its bony substance.

5. The post-glenoid is short and stout, and is slightly embraced by the tympanic, and that to a greater or a lesser extent in individual skulls.

From the hypothetical type, then, we here note the following departures, being the sum total of the evolution of the external (bony) ear of the Kangaroo:—

1. The par-occipital has grown in thickness, by the addition of a moiety (upon its inner side) from the mastoid, so that it now forms the inner half of the process.

2. The mastoid has bounded the skull by a truncated process.

3. The post-tympanic has retained its original characters, more mesiad than distad.

4. The tympanic has grown, to compensate for the reduction of the post-tympanic, and most likely altered its direction.

5. Owing to the changes just noted, the post-glenoid has become more directly associated with the tympanic.

THE TASMANIAN WOMBAT.

In this marsupial we may observe:—

1. The par-occipital has been forced mesiad, and does not, by a long way, bound the occiput.

2. The mastoid forms a mastoid process, actually bounding the skull.

3. The post-tympanic is in-stepped, and forms the median boundary wall of the occiput, and is thin and knife-edged in structure.

4. The tympanic surrounds, without touching, the post-glenoid, but is more closely associated with the post-tympanic. In young animals, however, it is central, showing that the change of direction is relatively recent.

5. The post-glenoid is a well-marked process, but excavated by air cells.

The changes thus manifested show that in its evolution the wombat has:—

1. Dwarfed the par-occipital, and driven it mesiad.

2 & 3. Produced the mastoid and post-tympanic.

4. Altered the tympanic to meet the condition of enlargement (by means of air cells) of the whole region of the ear.

5. Retained, but re-adapted, the post-glenoid.

The needs that stimulated these changes were met in a somewhat different way in the Hairy-nosed Wombat of South Australia. in which animal the tympanic has retained its central position, by throwing out extensions to meet the post-tympanic, and the post-glenoid. The latter process has dwarfed to the merest semblance of its former greatness, the enlarged tympanic, and the enormous air cells being, at present, the chief features of the ear.

These changes in Wombats amount to as much or indeed rather more variation from the assumed type as we found among Kangaroos.

THE NATIVE BEAR.

1. The par-occipital bounds the occiput, and is a direct outgrowth from the ex-occipital, receiving nothing from the mastoid.

2. The mastoid unites with the post-tympanic in a knife-edged upper bounding wall.

3. The post-tympanic strongly over-arches the tympanic.

4. The tympanic is a slightly marked tube recessed into the central portion of the bony ear.

5. The post-glenoid is large and dilated by air cells into an extensive chamber easily half the size of the true bulla—which latter is enormous.

Comparison with the hypothetical type (6) will show the following retentions and variations:—

1. The par-occipital must be almost, if not quite, a replica of the type.

2. The mastoid has also varied little.

3. The post-tympanic strongly over-arches the ear, and retains much of its original importance.

4. The tympanic ring has dwarfed, and become recessed, but still retains its central position. It embraces the post-glenoid, and presents a surface to the post-tympanic and mastoid.

5. The post-glenoid is large, and dilated extensively by air cells, forming, in fact, a chamber half the size of the enormous bulla (as already said), the whole of which are departures from the type.

THE TASMANIAN PHALANGER.

1. The par-occipital is removed mesiad.

2. The mastoid, which bounds the occiput, is to all intents and purposes a large air chamber. Ventrad it extends to and coalesces with the true bulla, and the tympanic, as well as with the par-occipital.

3. The post-tympanic is also a large air chamber extending without a break across to the squamosal portion of the zygoma.

4. The tympanic has coalesced with the surrounding bony elements of the ear, a slight notch alone indicating its separation from the post-tympanic.

5. The post-glenoid is well defined forward, but backward is ankylosed to the edge of the tympanic ring, which latter is very thin.

In Cook's Phalanger the variations are as follows:—

1. The par-occipital is long, as in the assumed type, but does not quite bound the occiput.

2. The mastoid extends well up the skull, and early coalesces with the other bony moieties of the ear.

3. The post-tympanic is not separate from the other squamosal elements, but unites with them to bound extensive air chambers.

4. The tympanic is more ring-like, and stands out farther, than that of the other phalanger.

5. The post-glenoid is thin, and has coalesced with the tympanic; in fact, the whole area is a mass of air cells, through which the tympanic ring penetrates.

Having thus passed in review the several expansions, contractions, and suppressions of the bones of the ears of those marsupials that chiefly interest us in our quest. we can see that every important change of life they were called upon to meet wrote a well-defined record upon their otocranes.

Wombats, adapting themselves to a fossoral life, altered the whole character of the ear in some such way as that noted above, while the hairy-nosed race developed specific variations from the generic variant. What is true of the wombats is true of the whole group just passed in review, and, accordingly, when we come to deal with the *Nototheria* we may reasonably expect to encounter similar changes, and once having found them, to use them, if so required, for taxonomic purposes.

NOTOTHERIUM MITCHELLI.

If we had to change the ear of any existing Tasmanian marsupial into one similar to that of *Nototherium mitchelli*, the ear most easy of such a conversion would be that of *Trichosurus vulpecula*. To accomplish the change it would only be necessary to bend forward the mastoid process, and ankylose it to the post-glenoid. As already pointed out (P. and P. Roy. Soc. Tas., 1920, page 108), our studies led us to conclude that the ear of *N. mitchelli* had been formed by an equal blending of the post-glenoid, post-tympanic, and mastoid processes, together with a coalescing of the tympanic ring, until the whole represented a solid bony mass, and these extended researches among allied marsupials (that

show changes rung upon every moiety of the bony ear) render this statement as feasible to-day as it was then The absence of a series of immature skulls of the giant marsupial render it at present impossible to absolutely check the steps in this evolutionary process, but as we said in our paper *(loc. cit.)*, the ear of *Nototherium tasmanicum* was a stage nearer the primitive condition, as will now be duly shown.

NOTOTHERIUM TASMANICUM.

Not being called upon to thicken up the skull to support a fighting weapon of appreciable size, this creature shows specific differences about equal to those that obtain between the common mainland wombat and that of the hairy-nosed form of South Australia.

All the elements of the bony ear can be traced, and their several dispositions are as follows:—

1. The post-glenoid has bent backwards, and fuzed with the post-tympanic.

2. The tympanic ring can still be traced.

3. The post-tympanic has coalesced with the post-glenoid, their union forming (distad) a bony process.

4. The mastoid still shows as a blunt process—it and ex-occipital bound the occiput.

5. The par-occipital, which is a massive process, is removed mesiad some 50 mm.

This amount of variation, between the two animals named, is great, as is usually found among specifically distinct marsupials.

And now let us re-ask the question: Do these changes among marsupials agree at all with those found among their non-marsupial analogues? Let us see.

DINOCERAS MIRABILE (MARSH).

In this animal the following conditions obtained:—

1. The par-occipital was dwarfed.

2. The mastoid strip of the periotic appeared upon the surface.

3. The post-tympanic was large, and bounded the auditory meatus.

4. The tympanic was recessed, and seemingly was more foraminal than tube-like.

5. The post-glenoid was a large and powerful process. In *Dinoceras laticeps*, there is a marked tendency to blend the ear bones into a solid mass.

In *Tinoceros ingens* (of Marsh) everything posterior to the auditory meatus is fused into a bony unit, a condition that apparently supervened upon the evolution of the fighting bosses. These several studies teach us that with the incoming of fighting habits, the variations of the otocrane are markedly similar, be the animal a more or less Tapir-like Marsupial, evolving weapons of offence, a Titanothere, or an ungulate, destined to become a true Rhinoceros. If we carefully weigh up the possibilities, however, that present themselves to us, as the results of any such sequence as that we have been dealing with, the conviction grows that mere environmental stress will not account for all the conditions met with. In other words, we think that evolving races of animals follow a more or less orderly sequence, plus, and minus, local conditions, for one of which biological factors we used the term "Rhinoceros Trend" in our former papers to this Society. The hasty rejection, by early evolutionists, of the law of "correlated modifications" was an unwise step, for what was really wanted was a wider and more literal use of it, rather than its elimination as a mere superficiality.

"Parallel Evolution," and similar terms, are shorn of much of their force if nothing exists behind them, as a *vera causa*, but environmental pressure. The few notes here presented are but a portion of a much larger collection made by us, including a comparative series from the existing ungulates, but space forbids their inclusion into the present text. We might also have followed out the ratios of environmental effect upon the otocranes of the marsupials named, with a view to estimating the amount of the unaccounted for balance, had conditions of publication so favoured us.

LITERATURE.

1884 Monograph of the *Dinocerata*, U.S. Geol. Survey, Vol X., 1884, by Prof. O. C. Marsh.

1920 Studies in Tasmanian Mammals, living and extinct, P. and P. Roy. Soc. Tas., by Scott and Lord.

TWO INTERESTING FUNGI.

By

L. RODWAY, C.M.G., Government Botanist.

(Read 14th April, 1924.)

In June, 1902, I sent an underground fungus to Kew to be named, and with the hope that a description would be published in due course in the Kew Bulletin. George Massee, who at that time controlled the fungus department, suggested for it the name *Secotium sessile*. but it appears a description was not published.

In the year 1911 I read a paper before the Royal Society of Tasmania on the *Hymenogastraceæ* of Tasmania, including therein four *Secotiums*. In all good faith I described *S. sessile*, believing it had already been described by Massee. Mr. G. H. Cunningham, Mycologist of New Zealand, now points out that, according to modern ideas, the presence of Cystidia places this tuber in the genus *Elasmomyces*, and advises me to describe it as a member of that genus.

Elasmomyces sessile, n.n.—Subterranean, then emerging at maturity, subglobose, 3-4 cm. diameter, white, then pale red on exposure; stem-like base well developed, piercing to the middle or sometimes to the apex of the tuber. Peridium very thin, papery. Gleba white, becoming cream-coloured, canals very contorted, the tramal plates mostly radiating from the sterile column, sometimes very like contorted gills. Cystidia numerous, fusiform, 40-50 μ. long. Spores globose, minutely echinulate, hyaline, 9 μ. diameter.

Gathered on the lower slopes of Mt. Wellington and Mt. Field. Rare.

Æcidium celmisium, *n.s.*—Æcidia irregularly clustered on the external surface of the leaf. Peridium white, much exserted and torn. Spores irregularly oblong, hyaline minutely but closely verruculose, 40-50 x 30 μ.

On leaves of *Celmisia longifolia* at Collins' Bonnet. Altitude, 4,000ft.

NOTES ON A GEOLOGICAL RECONNAISSANCE OF THE MT. LA PEROUSE RANGE.

By A. N. Lewis, *M.C.*, LL.B.

Plates I.-VIII.

(Read 14th April, 1924.)

SYNOPSIS.

1. INTRODUCTORY.

(a) General.

The notes here published are the outcome of a hasty general reconnaissance made during a trip to Mt. La Pérouse at Christmas time, 1923, by a party consisting of Messrs. A. V. Giblin, H. R. Hutchison, V. C. Smith, V. E. Chambers, Dr. J. Walch, Major P. G. Dodson, and the writer.

(b) Geographical Position and Access.

The country commented on is that part of Southern Tasmania lying between Southport and the mouth of New River. Only the more elevated portions of the ranges lying between those places were examined. The general position of the area here described can be seen from Plate I.

Access to Mt. La Pérouse can be obtained from any of the settlements south of the Lune River. Only one track exists, and that is scarcely better than a line of blazes with some of the undergrowth cleared away. It follows the ridge forming the southern edge of the Lune River Valley, starting from a timber tramway near the limestone quarries, south of the Lune, and about five miles from the Ida Bay settlement. Thence it rises very steeply nearly two thousand feet to Moonlight Flat. From this place there is no track, but once on the top of the main range the going in any direction is easy. The party referred to followed the above route. Access can also be gained from any of the settlements surrounding Recherche Bay, but first the dense forest to be penetrated, and then the steepness of that side of the mountain, would render an appreach from anywhere but the Lune River very arduous.

(c) Previous Literature, Explorations, and Nomenclature.

The writer has been unable to find any description of the La Pérouse Range. In 1898 Mr. H. W. Nicholls read a paper on the Geology of La Pérouse before this Society (Nicholls, 1898), but, unfortunately, the paper was not published in full. The abstract in our proceedings is too brief to be useful, and the paper has now disappeared. The coastal plain from Strathblane to the mouth of the New River has been very fully described. (See Twelvetrees, 1915 (i.) and (ii.), and references to previous work there given, and Reid, 1922.) This paper deals with a triangle of country surrounded on the east and south by these districts.

The name *La Pérouse* first appears on Sprent's map of 1856, and it appears to have been given when the trigonometrical survey was being carried out, obviously after the great explorer for whom D'Entrecasteaux and Kermandec were searching when they mapped and named the adjacent coast. D'Entrecasteaux's chart, 1793, does not name the mountain, but shows four peaks, evidently Precipitous Bluff, Leillateah, La Pérouse, and the conical hill west of Recherche Bay. Cook, in a chart made during his third voyage in 1777, marks a range of mountains, and places the words "*Peaked Hill*" alongside what is evidently Leillateah. In an accompanying panoramic sketch, made from the south-west of South-East Cape (his South Cape), he shows a peculiarly-shaped hill, evidently Precipitous Bluff. Leillateah and

La Pérouse can also be picked out, but they were not named. Hayes, in 1793, sketched in the range of mountains from the South Coast to New Norfolk. He named Leillateah *Pinder's Peak*, and writes the words, *"Rugged Mountains,"* alongside La Pérouse. Hayes's nomenclature was evidently overlooked during later surveys.

Lady Franklin, in her diary of 1838, written when weather-bound in Recherche Bay on the way to Port Davey, and now, through the generosity of Mr. W. F. Rawnsley, her great-grand-nephew, and the activity of Mr. A. H. Ashbolt, in the hands of the Royal Society of Tasmania, mentions this range. She states that her party named it the Research Range, and the two prominent peaks, now known as Leillateah and La Pérouse, as *Mt. King* and *Snow Ridge* respectively. These names likewise do not appear to have ever found their way on to official maps. In 1849 Dr. Milligan published his careful report on the occurrence of coal in this district, and does not give a name to the mountains.

Mr. James Sprent visited the mountain during the course of the trigonometrical survey, 1844-1856, and evidently bestowed the name La Pérouse, but, strange to relate, does not appear to have plotted Leillateah, the most outstanding feature to the south of La Pérouse. Mr. G. S. Perrin made a report on the area between Adamson's Peak and La Pérouse for the Lands Department in 1886, and Mr. T. B. Moore crossed the range when constructing his track to Port Davey in 1900, and again in 1901. Both these gentlemen left maps which are now preserved in the vaults of the Survey Department, but they show too little detail to be of any great assistance.

Mr. T. B. Moore seems to have given the names to *Mts. Bisdee, Victoria Cross, Wylie, Alexandra,* and *Precipitous Bluff,* although from his sketch the exact location of the peaks he so named is not always clear. He also gave the name *Mt. King Edward VII.* to the peak shown on the accompanying sketch as Leillateah. Mr. Twelvetrees speaks of a Mt. Leillateah (Twelvetrees, 1915 (i.), p. 20), but the hill he so names is the conical hill a couple of miles west of Leprena. Mr. Reid copied this nomenclature on to the map of the area in "The Coal Resources of Tasmania." After exhaustive inquiries the writer is satisfied that the mountain named Leillateah on the accompanying plans, and so called herein, is the original peak of that name, and has been thus known by residents of the neighbourhood at least since 1890. If ever the

cartography of this area is revised by authority, it would be a fitting tribute to Hayes's work, and following the established practice of restoring the names first bestowed, to call the peak now named Leillateah *Pinder's Peak*, and leave *Leillateah* to the hill Mr. Twelvetrees so labelled. It is interesting to note, in passing, that Ling Roth gives the word "Leillateah" as the aboriginal name for what we now know as "Recherche Bay." The writer is indebted to Mr. C. E. Lord for calling his attention to several of the historical details set out above.

2. PHYSIOGRAPHY—A GENERAL DESCRIPTION.

(See also Twelvetrees, 1915 (i.), p. 5.)

The range of mountains stretching from the Huon Valley, between the junctions of the Picton and Arve with that river, southward to the sea at South Cape, is the dominating feature of the topography of the south-eastern side of the southern extremity of Tasmania. It is shown on the Survey Department's maps as the isolated peaks of Mt. Hartz, Adamson Peak, and La Pérouse, but in reality it is a continuous range, nowhere less than 2,000 feet in elevation, over 35 miles long, and several miles wide, out of which the prominences above named rise for another 2,000 feet.

On the western side of D'Entrecasteaux Channel lies a fertile coastal plain, some ten miles wide towards the north, narrowing to under five miles in the south. It is generally hilly, but its undulations are seldom over 500 feet in height, and are usually heavily timbered or cultivated to the summit. To the west the main range rises suddenly from this plain, with its eastern face, in general outline, a steep wall running somewhat west of north and east of south, projecting occasionally into the coastal plain in wooded spurs, and cut into deep gorges where the main streams descend. Approximately five miles farther west the plateau drops as suddenly to the Picton River, winding through a very fertile valley some three miles wide. To the south the range falls away precipitously to a narrow plain fringing the south coast, and on the north it descends in a series of thickly timbered ridges to the Huon Valley. This paper deals with the southern extremity of this range, from the Lune River Valley, southward.

The La Pérouse Range is the remnants of a plateau that once extended south from Adamson Peak for about ten miles, to within five miles of the coast, but which has been so

dissected that it is now a mere jumble of twisting ridges separated by deep precipitously-sided valleys. (See Plates I. and II.) The main range reaches its lowest elevation about half-way between the summit of La Pérouse and Adamson Peak, and this is a convenient point to start the description of the La Pérouse Range, although there is no definite feature at which it can be said that La Pérouse ends and Adamson Peak begins.

On the north of the La Pérouse Range, at about this junction, the Lune River rises in several branches. One has cut a great gorge in the southern slope of Adamson Peak, and another, rising in a deep, sheer-sided cirque in the heart of La Pérouse, flows for several miles due north towards Adamson Peak, then, joining other branches, flows still in a precipitously-sided canyon eastward to Southport. It thus cuts the northern portion of the La Pérouse Range into two parallel ridges, divided by a precipitous valley a thousand feet deep and about a mile wide. The western one of these two ridges curves gently, first west of north and then east of north, until it reaches Adamson Peak, which has considerable spurs running both east and west from the summit. This ridge consists of several wide, gently-sloping flats, divided by rough diabase or smoother sandstone prominences, the southern one of which is *Mt. Alexandra,* and its eastern slopes are drained by several branches of the Lune. The eastern ridge, known as *Moonlight Flat,* is about two miles wide from east to west and three miles from north to south, and forms a lower buttress to the main ridges of the La Pérouse Range proper. It drops sharply away on the east to the steep side of the mountain, and on the north and west to the cliffs of the Lune canyon, and averages about 1,800 feet in altitude.

To the south, Moonlight Flat rises in a succession of steps, often lines of low, broken cliffs, attaining an elevation of about 2,600 feet about four miles from the northern edge, and some three miles south of where the Lune track debouches. From this point the long ridge shown on the accompanying sketch as *Sandstone Ridge* rises for another 800 feet. Sandstone Ridge runs north and south for about two miles. Its summit is a sharp razor-back, cut by erosion into four prominent hills separated by saddles some two hundred feet lower.

The most northerly of these four prominences of Sandstone Ridge (indicated as *No. 1 Hill* of Sandstone Ridge on

the accompanying plan) presents a steep even face to the north as it rises above Moonlight Flat. To the east it is extended in a spur running out a few hundred yards to the general line of the eastern slope of the mountain, and to the west it drops sharply to the cliffs which fringe the Lune River cirque. This height is joined by a saddle, some 200 feet lower than the summit, to the next prominence in succession to the south. From this second height a long, flat-topped ridge runs for about a mile to the eastward. The top of this ridge, a couple of hundred feet or so lower than the average height of Sandstone Ridge, is almost horizontal and quite straight, but only a few yards wide. Its eastern end is flanked with diabase cliffs, but here the diabase does not rise above the general level of the ridge. Looking at it from north or south it appears to be the edge of a level plateau, and the name of *Tabletop* has been given to it. From the top of Tabletop and the easterly extension of the first hill the ground drops precipitously to the bottom of a wide valley a thousand feet below, which cuts into the mountain from the east, and is called, on the accompanying sketch, the *North D'Entrecasteaux Cirque.* It is drained by a branch of the D'Entrecasteaux River, which empties into Recherche Bay at Leprena.

A little south, and on the western side of this second height, the Lune canyon ends abruptly in a continuous half-circle of cliffs a thousand feet high. (See Plate IV., Fig. 2.) This canyon, as has been explained, cuts deeply into the main mass of the mountain. Where it ends a narrow col connects Sandstone Ridge with the Mt. Alexandra and the western ridge running north to Adamson Peak. This col is only a couple of hundred yards wide, and then the ground dips sharply to the south. The highest point is right on the edge of the cliffs overlooking the Lune gorge, and from this point the drainage is all to the south, to a branch of the Picton River. The south end of the Mt. Alexandra spur extends about half a mile farther south than this col, and here a branch of the Picton that drains a considerable portion of the La Pérouse Range runs in a valley over a thousand feet below the level of the ridges. So this col provides the only high level connection between the eastern and western ridges of the north of the La Pérouse Range. In 1900 and 1901 the late Mr. T. B. Moore explored a route from Southport to Port Davey, and used this col as a means of access to the western ridges. The name, *Moore's Bridge,* has been given to this col in honour of the memory of one of our greatest explorers.

whose name is hardly commemorated at all, though he gave names to most of the features of Western Tasmania. The stakes marking Mr. Moore's track can still be easily followed, skirting the north-west of Sandstone Ridge and crossing the Bridge.

The second height of Sandstone Ridge is connected to the third by a saddle slightly lower than that connecting the first and second. This third prominence rises straight up from the eastern end of Moore's Bridge. It, also, has a long extension to the eastward. A sharp-crested, level-topped sandstone ridge runs east for about three-quarters of a mile, parallel with Tabletop, half a mile across a second deep, steep-sided valley to the north, named the *Centre D'Entrecasteaux Cirque*, and also drained by a branch of the D'Entrecasteaux River. This ridge terminates in a mass of diabase, standing several hundred feet above the level of the ridge, to which the name *Mt. Hippopotamus* has been given. It is a peculiarly gnarled piece of rock, only ascendable by occasional chimneys, and with many overhanging ledges. It forms one of the most characteristic features of the range. From its summit the ground drops in a series of precipices to the coastal plain nearly three thousand feet below. On the west side of this third hill of Sandstone Ridge a small stream rises, which, after flowing in a steep gully to the north-west onto the eastern end of Moore's Bridge, swings round to the south and eventually joins the Picton. The fourth rise of the top of Sandstone Ridge is connected to the third by another saddle. This is the southern terminal of Sandstone Ridge, which drops in a series of steps to an elevation of about 2,900 feet, leaving a high level pass between its southern end and the next ridges to the south.

A mile to the south and south-west of this southernmost top of Sandstone Ridge and running in a north-west-south-easterly direction is *Maxwell Ridge* (so named by parties visiting the mountain after Mr. Eustace Maxwell, who has led several trips to this district), a narrow flat-topped sandstone ridge 3,500 feet in elevation, and connected to the south-east with the summit of La Pérouse by a low saddle. Between Sandstone Ridge and Maxwell Ridge lie the two largest lakes on the range. The north-eastern side of Maxwell's Ridge drops in beech-clad cliffs for 800 feet. Close under these is the end of the upper lake, a small triangular-shaped sheet of water about four hundred yards long and two hundred and fifty yards wide at the northern end, at

which end it overflows to the second lake. The water is dammed by a bar of rock, gently sloping on the southern, or upstream side, and forming a small cliff on its northern side. This rock bar from a little distance looks so artificial that it at once suggests a man-made reservoir, and the name *Reservoir Lakes* has been suggested for these two sheets of water. (See Plate V., Fig. 1.) The lower Reservoir Lake lies about a hundred yards north of the rock bar damming the upper lake, and is about 30 feet lower in altitude. It is of irregular outline and dammed by a morainal wall over which the outlet of both lakes flows as a stream running a few hundred yards north and then swinging in a wide circle to the westward. Moore's Bridge lies a mile north of these lakes. On its southern side a steep-sided amphitheatre has been cut into the Bridge and the south-east of Mt. Alexandra. Into this flows the stream mentioned before as rising in the third hill of Sandstone Ridge. Several other streams flow south from this amphitheatre, and, joining that rising in the lower Reservoir Lake, form a very considerable branch of the Picton. This branch flows to the main stream westward in a deep gully between Maxwell Ridge and the southern spurs of Mt. Alexandra.

Maxwell Ridge stands about 3,600 feet in altitude, a level, razor-backed ridge of sandstone, dropping sheer to the Reservoir Lakes on its north-east side and to the tributary of the Picton before mentioned on the north-west. Between these a long ridge runs out to the bend of the outlet stream of the lakes, giving a means of access to the summit from the north. Another spur runs out half a mile or so to the west, decreasing in height from the top of the ridge by a series of steps, until it overlooks the wooded slopes of the Picton Valley, which winds northward past the Hartz Mountains to the Huon Valley, faintly discernible against Mt. Weld and the Snowy Mountains on the northern sky-line. To the south, Maxwell Ridge is connected by a saddle to Mt. Leillateah. This will be referred to later. To the south-east a low saddle, about 3,000 feet high, connects Maxwell Ridge to the ridge on which the trigonometrical station of La Pérouse stands.

This main summit of La Pérouse is the highest portion of the range, the trigonometrical station standing at an altitude of 3,800 feet above sea level, and is the highest point between Leillateah and Adamson Peak, although the highest points of Maxwell Ridge, Sandstone Ridge, and Mt. Alex-

andra are barely a couple of hundred feet lower. (See Plate IV., Fig. 1.) This portion of the mountain is a circular bastion. only four hundred yards in diameter at the top and surrounded with cliffs over a thousand feet high, except for the north-east corner, where a spur runs off to the eastward, and the western side, where the saddle mentioned before connects it with Maxwell Ridge. On the north face a mass of diabase, which projects from under the sandstone capping of the mountain in a straight line with Mt. Hippopotamus on the end of the next spur, a quarter of a mile farther north, has been exposed by the erosion of the soft sedimentary rocks on both sides, and now stands out as a spur of La Pérouse into the valley to the north. Its sides and end are perpendicular, and its summit has been eroded to a succession of points. For this reason it has been called *The Comb Ridge*, and it presents one of the finest scenic features of the range. (See Plate III., Fig. 2.)

Between the summit of La Pérouse and the saddle connecting it with Maxwell Ridge on the south, and Mt. Hippopotamus and the ridge connecting it with Sandstone Ridge on the north, lies a deep, steep-sided valley, marked on the sketch as the *South D'Entrecasteaux Cirque*, into which the Comb Ridge projects at right angles from the southern side for about half a mile. (See Plate VI., Fig. 1.) This gorge is narrow, precipitous, and straight-sided, although flat-bottomed up to a line between the Comb Ridge and Mt. Hippopotamus. Then to the west its head has been considerably enlarged, and a great quarry-like amphitheatre has been cut in the northern face of the main La Pérouse ridge. It terminates in a semi-circle of cliffs about two hundred feet high, at the southern end of which a considerable stream descends in a fine waterfall. Above these cliffs is a ledge several hundred yards broad, running round the eastern face of the fourth or southern prominence of Sandstone Ridge. This ledge averages about 2,800 feet above sea level, and has been extended westward between the end of Sandstone Ridge and the saddle connecting the summit of La Pérouse and Maxwell Ridge until it meets the southern end of the valley in which the Reservoir Lakes lie, thus forming the high level gap between the branches of the D'Entrecasteaux and Picton Rivers, the highest point of which is about 600 feet lower than the average height of the top of the surrounding ridges, although topographical difficulties render it useless as a means of passage through the range.

The highest point of this gap naturally forms the watershed in this locality between the branches of the D'Entrecasteaux and Picton Rivers. Somewhat to the south-west of the southern end of Sandstone Ridge lie three small tarns. The most northerly drains into the centre of the three, and their overflow then finds its way to the north into the upper Reservoir Lake. The most southerly, separated from the centre one by only a few yards of peaty swamp, drains east to the D'Entrecasteaux.

A hundred yards east of the trigonometrical station at the summit of La Pérouse the edge of the mountain drops away in a cliff some hundred feet high to a ledge less than a hundred yards wide, which runs round the eastern face of the mountain. From the north-eastern corner of this ledge a high spur, the divide between the D'Entrecasteaux and Catamaran Rivers, extends in an easterly direction for three or four miles, its lower extremities reaching nearly to Recherche Bay, between Leprena and Catamaran. It leaves the main ridge of the mountain at an altitude of about 3,600 feet, but rapidly decreases in height by a series of steps which consist in most cases of cliffs of fluted diabase. In front of one of these, about a mile east of La Pérouse, is a handsome stack or pillar separated from the main cliff by erosion. Towards the eastern end of this ridge the direction changes to north-east, and after a comparatively low saddle the ridge terminates with a very handsome conical hill—a prominent landmark, both from La Pérouse and Recherche Bay. (It was this hill that Mr. Twelvetrees called Mt. Leillateah, and he mentioned its altitude as 2,630 feet.)

South of this long spur is a line of diabase cliffs, perhaps six hundred feet high, forming the eastern face of the summit of La Pérouse, and extending right across the southern face of this summit ridge and the saddle connecting it with Maxwell Ridge. They are unbroken except by one steep gully running south from the lowest portion of the above-mentioned saddle. From these the side of the mountain descends very steeply, probably for a further depth of 2,000 feet, to the bed of the wide valley of the Catamaran. So steep is this southern slope of La Pérouse that the face of the mountain is scarred with numerous landslides, some very recent, others more or less healed by time and covering vegetation.

Under these diabase cliffs, lie two remarkable little lakes. The northern edge of the more northerly lies in the corner between these cliffs and the eastward spur mentioned above. It is roughly circular, and about four hundred yards in diameter. The cliffs descend for six hundred feet sheer to the water's edge. A hundred yards farther round, on the south-east side of the mountain, is the second lake, remarkably like the other in every respect but about half the size. These two lakes, clinging to the face of the mountain like a swallow's nest stuck on a wall, are impounded on the very steep mountain slope each by a semi-circular embankment 150 feet above the level of the waters of the lakes. The lakes appear very deep and are one of the scenic sights of the mountain. There is no apparent outlet, although at no very distant date the larger appeared to flow into or to join the smaller by a channel close under the cliffs. Probably there is a certain amount of soakage through the loose material of the impounding bank.

The summit of Leillateah stands about a mile and a half (H.E.) due south-west from the top of La Pérouse. (See Plate VII., Fig. 1.) It is a very handsome, symmetrical, concave-sloped peak, with four precipitous sides, each separated by a buttress-like ridge. Its altitude is 4,200 feet above sea level. This reading was given by carefully checked aneroids set at the trigonometrical station or La Pérouse. It is also the height given on the Admiralty Chart for Leillateah, which is shown there in its correct place, but not named. It is curious that this rugged peak, one of our finest mountain features, should not have received more notice. Although it is within a day's easy walk from La Pérouse, and the most prominent feature in the landscape of the extreme south of this range, the trigonometrical survey did not indicate it on their map, and it has been ignored by the Survey Department. Even Mr. Perrin, who sketched the rest of the range on his plan and ascended to the summit of La Pérouse, does not indicate the existence of Leillateah. Perhaps this extreme sentinel is so often wreathed in mists blown from the southern seas that it has not been observed by the survey parties.

From Maxwell Ridge, several hundred yards west of the saddle connecting it with La Pérouse, a second saddle branches off to the south. This saddle, leaving Maxwell Ridge at an elevation of about 800 feet lower than the summit, and after descending slightly for a few hundred yards,

rises quickly to a pointed eminence about 3,700 feet in altitude. This is followed in a southerly direction by a second eminence slightly higher than the first, to which it is joined by a somewhat lower saddle. To the east these saddles and peaks drop in a precipice sheer from the summit to the bottom of the Catamaran Valley a thousand feet below. To the west the ground drops sharply for a few hundred yards, and then very steeply to the bottom of the valley of a tributary of the Picton, which is divided from the valley of the Catamaran by this very narrow but high ridge.

From each of the two prominences on the southern end of this connecting saddle, spurs run out a short distance in a north-westerly direction, enclosing a ledge at an elevation of about 3,000 feet, on which rests a pretty tarn. (See Plate VII., Fig. 2.) This is roughly circular, and several hundred yards across, but very shallow, and with a deposit of yellow ooze on its floor. Dr. Walch, who examined some of this mud microscopically, reports that it consists of at least 50 per cent. of remains of diatoms of several well-known varieties. On the surface of the mud, and on water plants, were quantities of a small bivalve shell, which Mr. W. L. May reports belong to the genus *Spærium.* The species, he says, is indeterminate, but from the specimens brought back by the writer, he thinks the shells are immature specimens of *Spærium tasmanicum.* (See May, 1921.) Tenison-Woods described the species under the genus *Cyclas.* (Tenison-Woods, 1875.) As the specimens collected were the largest visible, and many dead shells were seen, none of which was any larger, it appears to the author that they may not be immature specimens, but a different variety. The subject is interesting, and well worth investigating by some student with a biological training. The whole subject of the life in our mountain lakes opens a fine field for an enthusiastic naturalist.

From the southern of these two prominences, after a slight dip, the northern spur of the main peak of Leillateah rises steeply. To the west of this spur are broken cliffs, and to the east a precipitous but largely plant-covered face, dropping several hundred feet to a wide ledge on which repose two small tarns about two hundred yards long by a hundred wide. From this ledge the side of the mountain drops sheer a further five hundred feet or so to the bed of the Catamaran. Leillateah can be ascended without difficulty by descending from Maxwell Ridge to the connecting saddle, thence to the

lake on the west of the ridge, and up the spur on its south to the crest, and after crossing the top of the northern spur of Leillateah, by proceeding to the eastern spur along the face of the mountain, crossing this spur, and then completing the ascent by a vertical climb up the eastern face of the summit for the remaining couple of hundred feet.

As well as the spur just mentioned, three others leave the summit of Leillateah. One runs out a short distance from the south-western corner of the mountain, curving round in a broad half-circle to the north-west, until it meets Mt. Wylie, and thus forms the southern watershed of the head of the Picton River. A second spur runs off to the east, for about two miles, forming the southern side, first of the ledge, mentioned above, at the head of the Catamaran, and then of the main gorge of the Catamaran River. In the northern side of this spur, which along its whole length descends steeply to the Catamaran, are two great amphitheatres, ringed with cliffs and drained by branches of the Catamaran. In the western and smaller one is a pretty lake perched half-way between the crest of the spur and the bottom of the forest-covered Catamaran Valley. East of the second gorge this spur merges into the fourth buttress of the main mountain, which, leaving the summit in a south-easterly direction, runs out towards South Cape Bay.

These two spurs on the east of the mountain are quite distinct close to the summit, but soon merge and enclose a flat several miles long and half a mile broad on which lie three considerable lakes, with a fourth and several large pools close up under the mountain. The outlet from these lakes appears to drain south through a gap in the ridge to one of the rivers running into the sea at the south coast, perhaps into South Cape River. These spurs all drop steeply away from the summit of the mountain, which ends in a perfect point. The crests of the spurs are extremely rough, with projecting ends of broken diabase columns. Between the spurs the slope of the mountain is precipitous, and in most places quite unascendable. From the summit, and from the crests of the south-eastern and south-western spurs, the face of the mountain drops precipitously to sea level. A narrow coastal plain, a couple of miles wide, near the mouth of the New River, and much narrower farther east, skirts the foot of the mountain. (See Twelvetrees, 1915 (ii.), for a description of this.)

Parallel with the La Pérouse Range and about five miles farther west runs another range, the three highest portions of which Mr. Moore named Mts. Wylie, Victoria Cross, and Bisdee. These are rugged, forbidding masses of diabase, capping the sandstone composing the lower levels of the range, and they attain approximately 4,000 feet. (See Plate VIII., Fig. 1.) Between these mountains and the western ridges of La Pérouse runs the Picton Valley, here straight, broad-bottomed, and flanked with many precipices. The western tributaries of the Picton rise in gorges cut deeply into the mountains mentioned above.

From Mt. Wylie a spur runs out several miles farther west to the base of Precipitous Bluff, a great mass of rock, perhaps half a mile long, from north to south, and standing five hundred feet perpendicularly above the surrounding ridges, with a close resemblance to Cradle Mountain from the Plateau at Katherine's Tarn. To the west, Precipitous Bluff drops straight down to the bed of the New River, which empties into a deep lagoon dammed by sand dunes several miles long extending from the sea beach to the foot of Precipitous Bluff. (See Plate VIII., Fig. 2.)

3. GEOLOGY.

(a) Stratigraphy.

The stratigraphy of the La Pérouse Range is simple. The only rocks exposed in the area covered by these notes are Trias-Jura sandstones and shales, which form the bulk of the mass of the La Pérouse Range, and intrusive diabase (dolerite) of Cretaceous age. The rocks of the coastal plains to the east and south have been described in detail. (See Twelvetrees, 1915 (i.) and (ii.), and Reid, 1922.) These are outside the limits of this paper.

Here, as elsewhere in Tasmania, it is difficult, without very close work, to decide the point of junction between the Permo-Carboniferous sediments and those of Trias-Jura age. The strata of the higher levels of the mountain consist of massive beds, several hundred feet thick, of grits, evidently the basal grits of the Trias-Jura, succeeded by five hundred feet or more of Ross series sandstones (see Geological Survey of Tasmania, 1922, p. 6), which corresponds to the Knocklofty series of Mr. Twelvetrees's earlier classification. The sandstone is mostly of a coarse variety, but varying

locally from a grit to a shale, and varying sharply in colour from layer to layer, but it is predominantly pale yellow, changing to grey-white on weathered surfaces. It is interbedded with numerous, relatively thin, layers of shale often with a high carbon content and varying in colour from grey to black. Together, these give a banded appearance to all the cliff faces and other exposures. The beds are almost horizontal, dipping very slightly (seldom more than 2 degrees, but up to 5 degrees under the summit of La Pérouse) in a north-westerly direction. This dip can only be distinguished in places where the beds are exposed for a considerable length. In places the sandstone changes to a grit, often quite coarse and occasionally becoming a conglomerate of fine round water-worn pebbles of quartz. In places, notably on the ledge forming the first step rising south of Moonlight Flat and in the cliff face south of the Reservoir Lakes, thin layers of this conglomerate can be traced interbedded in the sandstone layers for many hundred yards.

Microscopic examination of several casually collected specimens of this sandstone shows the component particles to consist predominantly of quartz grains as is usual with the Ross sandstones throughout Tasmania. The proximity of the derivative beds of quartzite to the west would account for this. The sandstone is very much cross-bedded. This and its general coarseness and the many interstratificated layers of pebbles indicate that it is a much closer inshore deposit than the rocks of the similar series round Hobart and those of the type locality in the Midlands. It is interesting to note that on the crest of the ridges where frost and wind erosion are now very active the sandstone invariably weathers along the planes of the current bedding. This at first sight gives the appearance of high inclination and even folding to the surface exposures, but the true stratification planes can be clearly seen in the sides of the many cliffs.

Above the 3,500 feet contour there is a change from the Ross series to the felspathic sandstone series (the Ida Bay coal measures of Twelvetrees), small residuals of which still remain on the tops of Sandstone and Maxwell Ridges. The last 200 feet of the summit of La Pérouse consists of rocks of this series. Proof of the age of these beds was found right under the cairn on La Pérouse by the discovery of numerous specimens of *Phœnicopteris* in the mudstone of the mountain top, and two

hundred yards due north of the cairn a fine spray of *Thinnfeldia odontopteroides* was found. (See Twelvetrees, 1915 (i.), p. 15, for references to descriptions.) These fossils were exposed by weathering, but were still in an excellent state of preservation. Doubtless, search would disclose other varieties. Some of the bands of black shale are full of plant remains, stems, etc., but no specimens sufficiently distinct for identification were found. These beds are apparently the very base of the coal measures, the great bulk of which has been removed by denudation.

Probably the sandstone beds pass downward into beds of Permo-Carboniferous age, but none such was seen on the higher levels of the ranges examined. Frost and wind have eroded the sandstones and shales of the ridge crests into flat slabs often exceedingly thin, and have given some very fine weathering effects. (See Plate III., Fig. 1.) The result is that the mountain top presents an aspect different from that of any Tasmanian mountain the writer has examined, and makes walking quite easy—very different from the *ploughed field* effect of the typical diabase cap. The general aspect of the topography resembles—apart from glacial forms—that of the higher ridges of the Blue Mountains of New South Wales.

The nature of the intrusions of the diabase (dolerite) can be studied here better than in any other place known to the writer, the cirques having exposed the whole "interior economy" of the mountain to view. As is usual with the intrusion of great sills of igneous rock the source of the ascending magma is not discernible, but in many places the *base* of the sill resting on the sedimentary rocks is exposed to view. The area of maximum occurrence seems to have been in the vicinity of where Leillateah now stands, whence the diabase pushed north and north-east.

That mountain is capped with 800 to 1,000 feet of diabase which, right to the summit, is of the coarse grained variety common in these masses, e.g., on the summit of Mt. Wellington. It rests on sandstone which can be seen passing out below it on every side of the mountain, and cirques have cut so deeply into the mass of the mountain without disclosing diabase below approximately 3,000 feet that if any connecting pipe exists it must be of very small dimensions and of much less diameter than the capping mass. It certainly looks, as far as field evidence can show, that this cap

is portion of a sill, probably a locally enlarged magmatic reservoir formed in the course of the intrusion of the sill. Similarly Mts. Wylie, Victoria Cross, Bisdee, and Precipitous Bluff appear to be diabase caps resting on sandstone, and, with Mt. Leillateah, may be a chain of laccolithic cores connected by horizontal, sill-like pipes, or they may be residuals of a large sill, similar to Cradle Mountain, the diabase cap of Mt. Anne, Mt. Wedge, and other portions of undoubted sills.

From the mass of Leillateah a dyke-like mass of diabase runs northward and forms the backbone of the saddle connecting that mountain with Maxwell Ridge. The eastern face of this saddle consists of a vertical wall of diabase resting on sandstone. The diabase here is some 500 feet deep. The exposure on the top of the ridge is a narrow band of glassy diabase obviously originally very near the edge of the intrusion and weathering in a way more resembling basalt. No diabase appears in the wall of the cirque cutting into this saddle from the west, so it is obvious that this dyke cannot be many hundred yards in horizontal width.

The diabase extends under Maxwell Ridge, rising again several hundred feet higher than the exposure on the top of the saddle, but to a height that falls short of that of the top of the diabase cap of Leillateah by a thousand feet, and then turning towards the north-east passes under the summit of La Pérouse. It outcrops along the south-eastern corner of Maxwell Ridge and right along the south-eastern and eastern face of the summit ridge of La Pérouse, forming the cliffs mentioned before. Here it is about 500 feet in vertical height, resting on sandstone and capped by over a hundred feet of felspathic sandstones. It caps the ridge that extends eastward from the summit towards Recherche Bay and the conical hill overlooking that arm of the sea. Close under La Pérouse the diabase is covered with a few feet of sandstone. An extension of this mass passes under the top of La Pérouse and projects as the Comb Ridge into the South D'Entrecasteaux Cirque. (See Plate VI., Fig. 2.) This occurrence is well over a thousand feet in vertical height and its bottom is not exposed in the floor of the cirque, which cuts right through it. It is here only a few hundred yards broad. Mt. Hippopotamus is a continuation of the same dyke, as are also the diabase cliffs on the eastern edge of Tabletop. Diabase occurs again flanking the eastern slope of Moonlight Flat and is observable here down to at least the thousand-

foot contour. It does not reach through to the western end of the South D'Entrecasteaux Cirque, which has enlarged its head in the sandstones of the summit ridge of La Pérouse behind the diabase dyke.

Several smaller sills and dykes branch from the main mass. Several masses appear in the northern face of the saddle connecting the summit of La Pérouse with Maxwell Ridge. The present surface of the north side of this saddle appears to have been the maximum distance reached by the diabase here. In many places masses of sandstone, more or less metamorphosed, can be seen included in the diabase. Opposite the end of Sandstone Ridge is a vertical face of diabase, jointed into a distinct, if irregular, hexagonal pattern, closely resembling the cooling surface of a basalt flow. This is evidently the termination of an off-shoot from the mass on the other side of the saddle.

A little farther west a small sill extends for several hundred yards under Maxwell Ridge, and can be traced in the cliffs overhanging the upper Reservoir Lake. It is about six feet high and has pushed its way through the strata along a band of soft shale, entirely replacing this rock, while the more massive sandstone strata above and below it have not been disturbed at all. There is a slight trace of metamorphism, but on the average not extending more than an inch from the contact. The diabase ends suddenly and the replaced black shale continues the stratum round the wall of the cirque. In one place, just above the D'Entrecasteaux-Picton divide in this cirque, a small enlargement or local reservoir has formed. This is a mass about 30 feet in height. Even here there has been no disturbance of the strata above and below. Beyond this bulge the sill continues through the strata exactly as before. A smaller sill has intruded for a short distance about 100 feet above the one just mentioned. In every case of these smaller or branch intrusions the diabase appears to have insinuated its way entirely by stooping, a bed of weak strata, usually shale or coal, having been attacked, and there is little, if any, evidence of force behind the intruding mass. In every case, including that of the biggest diabase masses on the field, there is very little metamorphism, the sandstone having been indurated for only a few inches from the contact. There is a small occurrence of diabase, south of the fourth prominence on the top of Sandstone Ridge, but with no indication of its connection with any other occurrence. This is in line with

the rock bar damming the upper Reservoir Lake, which consists of a band of indurated mudstone. Probably these are portions of another sill, the rest of which has disappeared in the erosion of the cirques.

With the exception of some small deposits of morainal material these are the only rock types on the La Pérouse Range.

(b) Development of the Present Topography.

(i.) Diabase Intrusions and Block Faulting.

The most striking physiographical feature of the district is the escarpment to the south of Leillateah and the dissected escarpment forming the eastern face of the whole La Pérouse range. The problem of the origin of these escarpments is the problem of the origin of the whole mountain system, and much work has yet to be done throughout Tasmania, which for this purpose must be considered as one geologic province, before the genesis of our mountains can be proclaimed with certainty. Obviously the diabase intrusions exercise a great influence on our present topography, and are, in order of time, the first factor controlling our landscape.

It is most interesting to follow, through the works of the last sixty years, the development of thought on the question of the origin and effect of our diabase. In 1915 Mr. Twelvetrees, after nearly twenty years' work, gave his opinion, which is in outline as follows (Twelvetrees, 1915 (i.), p. 17):—

(i.) The diabase intruded as a sill or intrusive sheet, slowly penetrating between beds of Permo-Carboniferous-Trias-Jura strata.

(ii.) It is older than the Tertiary Basalt.

(iii.) Block faulting subsequently produced the existing difference in level

(iv.) Original differences of level of the surface of the sill and differential weathering have produced minor inequalities

(v.) Erosion has largely removed the original covering from the diabase caps of the mountain summits.

(vi.) Sill rocks exist in various places concealed beneath sedimentary beds in the low country.

(vii.) There have been uprising columns of magma in some places, but these are few and far between.

(viii.) "It is straining possibilities to urge that the dia-"base on every mountain summit is part of an "ascending pipe restricted to each mountain."

The Geological Survey departed from this view, after much detailed study of the subject, in the course of their investigations of the Coal Resources of Tasmania. Their conclusions, due largely, the writer understands, to the work of Mr. P. B. Nye in the Midlands, may be summarised as follows (Geological Survey of Tasmania, 1922) :—

(i.) The date of the intrusions is probably Cretaceous.

(ii.) The diabase intruding the Permo-Carboniferous-Trias-Jura sediments *brought about* the existence of completely separated blocks of sedimentary rocks, located at any height above sea level varying from zero to over 4,000 feet.

(iii.) The structure of the diabase varies from place to place.

(iv.) Sills or intrusive sheets are known to exist in various localities.

(v.) Only a few forms of typical laccolithic structure have been located.

(vi.) "The greater portion of the diabase in Tasmania "can best be described as an asymmetric transgres-"sive igneous mass of a general laccolithic type."

(vii.) This rose upward lifting the sedimentary rocks bodily with it. It rose to a height greatly varying from place to place with a range of variation up to 5,000 feet, and this difference has caused the presence of different blocks of sedimentary rock at different heights above sea level. The higher blocks of covering sediments have been subsequently removed by denudation.

(viii.) A common structure is that of a broad and persistent dyke-like mass with numerous other dykes intruding as upward tongues.

The difference between these two opinions thus is: Have the major mountain systems of Tasmania (exclusive of the West Coast) been caused by post diabase block faulting, or are they due to the diabase intrusions alone? The rest of the observations in both opinions are now probably undisputed and can be considered proved.

Bearing on this problem the following observations on the La Pérouse district have been made by the writer:—

Firstly, diabase does not form the main mass of the mountain. Although it has modified the topography by presenting a harder surface to erosion than the softer sedimentaries, it occurs only as dykes and sills. It could in no way be compared to a batholith. It does not appear to have affected the western or northern portions of the range, and the sedimentary rocks there show a perfect continuity with those of the southern and eastern portions intruded by the diabase, and where it does occur it appears to cut across major topographical features and not to govern them.

In the second place, the elevated block forming the range stands over three thousand feet above the surrounding coastal plain, and nearly as high above the Picton Valley. Of this mass not a thousand feet in vertical height is diabase. Under the igneous rock are beds of sedimentaries. If the diabase raised the mountain block to its present level, how were the underlying sedimentaries raised, at least a thousand feet above rocks of a similar series a mile or so to the east?

Thirdly, there is a very sharp alteration of slope from the steep face of the mountain side to the undulating coastal plain, which the mountain escarpment meets at a well-defined angle. This slope exists in most places, if not throughout, in soft sedimentary rocks. Had erosion continued uninterruptedly from Cretaceous times, it would be difficult to account for this sharp alteration of slope. The streams which on the coastal slope have developed to a stage well on the way towards maturity, in their upper reaches are mere mountain torrents. It seems clear to the writer that normal river erosion has been interrupted. Also, the top of the plateau possesses a topography, apparently, to a certain extent, independent from the escarpments that form the flanks of the range. There are hills and valleys on the top of the plateau that cannot be accounted for by headward erosion of the few streams that drain down the sides, and for which glaciation cannot be wholly responsible.

Again, could a mountain of 4,000 feet elevation, consisting of soft coal measures and sandstone, have existed since Cretaceous times? Admittedly a certain depth of sediment has been removed, but at most not more than a thousand feet. Mr. Reid gives the greatest thickness of the adjacent beds of this age at Catamaran as 800 feet (Reid, 1922, p. 160), which very probably includes many feet of the underlying Trias-Jura Sandstone, while at least a hundred feet of coal measures still remain on the summit of La Pérouse. Probably only a few hundred feet of the original beds have been removed by erosion. Had these beds stood at that elevation throughout the whole Tertiary period, it seems to the writer that a much more mature cycle of erosion would have been reached.

And lastly, to the south of the Lune River, we have the following section running west from Southport. On the east, about four miles of Permo-Carboniferous strata with Cretaceous diabase and Tertiary basalt, seldom rising a hundred feet above sea level, is followed to the west by Silurian quartzites and limestones (Twelvetrees, 1915 (i.), p. 8) that rise to a height of 1,500 feet (Twelvetrees, 1915 (i.), p. 35). On their western border these old rocks abut on Trias-Jura sediments rising in one slope to 3,800 feet and persisting for several miles, after which they drop sharply to the Picton Valley, from 1,000 to 1,500 feet above sea level. This certainly appears to be the result of an upward *horst* in this particular area. (Also see Geological Survey, 1922, Plate IV., showing a very considerable fault following the present coastline from Recherche Bay to north of Port Esperance.)

These features all appear to be evidence of post-diabasic block faulting on a large scale. The writer does not presume, at any rate for the present, to dispute the conclusions of the Geological Survey as to the origin of our diabase capped mountains, a conclusion arrived at after several years in intensive study of this problem in the Midlands and elsewhere. But it certainly seems that the existence of the La Pérouse Range is not due to the uplifting of this block of country by the diabase, but by later block faulting on a large scale. The main lines of the east, west, and south coasts of Tasmania are admittedly governed by Pliocene or early Pleistocene block faulting, which has been very prevalent along the whole of eastern Australia. It seems to the writer that the theory advanced by the Geological Survey should

not be considered, at present at least, as the last word on the subject for all Tasmania. No evidence is as yet forthcoming whether the movement was upwards—a great upthrust of the block of country now comprising the range—or downwards—a dropping away of the coastal plain region—although the writer certainly prefers the former alternative. The movement was perhaps a very gradual one, but was certainly sufficiently rapid to prevent the streams regrading their courses during its progress. The coastal plain seems to have been subjected to oscillations during Tertiary and Quaternary times. (Twelvetrees, 1915 (i.), p. 19, and (ii.), p. 5.)

The writer therefore suggests the following stages in the development of the physiography of the region:—

(1) In Trias-Jura times a close inshore coastline receiving sediments from adjacent land to the west gradually rising to fresh-water conditions.

(2) Great earth movements *accompanied* by the intrusion of diabasic sills in great masses.

(3) The erosion of a definite topography, in process of which the diabase sills were exposed in many places.

(4) An epoch of major block faulting when the general outline of the landscape as we have it to-day appeared.

(5) The moulding of the details of the topography of the higher elevations by ice action.

(ii.) Effect of the Pleistocene Glaciation.

On this range, as in the case of most of the elevated portions of Tasmania, excepting some of the hills of the east coast, it is glaciation that has given us the actual landscape we see to-day. The cliffs that ring round the head of the Lune are the walls of a cirque, enlarged in the soft sandstones at the head of a glacier that, fed from the snow fields on Moonlight Flat and Mt. Alexandra, pushed in a stream over a mile broad for several miles down the Lune River Valley. This cirque now stands as a horseshoe of unbroken cliffs rising nearly a thousand feet from the valley floor. Its southern crest forms Moore's Bridge, a remnant of the original surface standing now as a high-level col between this cirque and the small one to the south of the bridge which is now drained by the Picton. (See Plate IV., Fig. 2.)

To the east of Sandstone Ridge were the seats of three glaciers which moved several miles to the eastward and were responsible for the three great cirques now drained by the D'Entrecasteaux River. These cirques increase in width from north to south, but they are all of approximately the same depth, viz., about a thousand feet below the general level of the ridges. They are very steep-sided, but cliffs are not common except on the south of the South D'Entrecasteaux Cirque. Several landslips of considerable size can be seen round their sides, and on the north side of the last mentioned one, a quarter of a mile of hill side has slipped and formed a small landslide lake on the side of the cirque. This has now been drained by a stream which was once its outlet. These cirques have extended their head until they have cut into the original crest of Sandstone Ridge for a hundred or more feet, forming the four hills that rise above the general surface of this ridge, the saddles between which being eroded during the erosion of the cirques below. In the South D'Entrecasteaux Cirque there is a ledge, also due to glacial action, several hundred feet broad, about a third of the way down from the general level of the top of the ridge to the floor of the cirque. From this ledge the walls of the main cirque drop precipitously. The glacier has cut right through the diabase intrusion which can be traced on the sides of the cirque, of which Mt. Hippopotamus and the Comb Ridge are remnants, and then has extended its head very considerably in the soft sandstones behind. (See Plate VI., Fig. 1.) A minor cirque has cut into the north-western side of the summit of La Pérouse and extended into the heart of the mountain until it has laid bare about half a mile of the diabase dyke. Another cirque has cut into the sedimentary rocks on the north-east of the mountain until now the more resistant diabase stands out like a wall, with its sheer sides over a thousand feet high projecting several hundred yards into the cirque. The top of the diabase evidently protruded from the ice at its maximum, and intense nivation has cut the crest of the diabase into a succession of sharp unscalable peaks, hence the name Comb Ridge.

Another very handsome cirque with a cliff face of 800 feet has cut into Maxwell Ridge from the north, and the glacier rising here was responsible for the Reservoir Lakes. (See Plate V., Fig. 1.) Its floor is at a greater elevation than the floor of the four cirques just mentioned; the height of the upper Reservoir Lake being 2,700 feet above sea level.

It thus approximates in height to the ledge above the South D'Entrecasteaux Cirque. The glacier from this cirque moved north for about a mile between Sandstone and Maxwell Ridges, and was then met by a short ice flow moving south from the south side of Moore's Bridge. Together these then bent west and passed between the end of Maxwell Ridge and Mt. Alexandra towards the Picton Valley. It was not ascertained to what point this glacier reached. In its track it met a band of indurated sandstone hardened evidently by contact with diabase, and riding over this while excavating the soft rocks above and below it, left it standing fifty feet above the general slope of the valley as a rock bar, crossing from one side of the valley to the other and completely damming it, banking back the waters of the upper Reservoir Lake. The glacier has worn the upstream side of this bar into a smooth, gently sloping incline, and has cut into the soft rocks on its downstream side, leaving there a sharp cliff about thirty feet high. (See Plate V., Fig. 2.) The portion of the valley around and below the lower Reservoir Lake is strewn with morainal deposits, and a high bank of this material deposited against the north-eastern spur of Maxwell Ridge dams this lake, and has been cut through to a depth of fifty feet by its outlet.

The general appearance of this valley suggests that the original pre-glacial drainage was from the vicinity of Maxwell Ridge straight north, across Moore's Bridge to the valley of the Lune. The main features of the parallel pair of ridges, Sandstone Ridge on the east and Maxwell Ridge and Mt. Alexandra and its continuations on the west, do not seem to be due entirely to the action of the cirques. Probably the original ice flow was in this direction, and later a cirque, cutting in from the Picton Valley, divided Maxwell Ridge and Mt. Alexandra and tapped the mountain valley south of Moore's Bridge. As has been explained, the ledge above the South D'Entrecasteaux Cirque has cut westward and joined an eastward extension of the Reservoir Lakes cirque, forming a gap between Sandstone Ridge and the summit ridge of La Pérouse. In this movement the D'Entrecasteaux Cirque seems to have been the active member, and has cut a small cirque at an altitude of 3,000 feet well into the southern end of the Reservoir Lakes cirque, and the numerous erratics strewn over the floor of this extension indicate that here the last movement of the ice was eastward and not northward. Again, the moraine impounding the lower Reser-

voir cirque consists largely of diabase boulders. To-day scarcely any diabase appears in the wall of the cirque from which this glacier rose, but the eastward extension of the D'Entrecasteaux Cirque is largely lined with it. So it seems that the whole of the space between Sandstone Ridge and Maxwell Ridge was once occupied by a glacier flowing north over the site of the lakes, but later the D'Entrecasteaux glacier cut through the divide and captured the southern extremity of this cirque, in the process of doing which it has pushed back the present divide between the two rivers for half a mile or more to the advantage of the D'Entrecasteaux. It is interesting to note that here diabase and sandstone have been plucked together from the cirque wall, consisting predominantly of sandstone. In a moraine a mile down the valley diabase boulders predominate, the softer sandstone having been reduced to a rock flour and now forming a muddy binding for an agglomerate of rounded diabase boulders of all sizes with a few small slabs of sandstone.

To the east of the summit of La Pérouse the two remarkable lakes perched on the steep slope of the mountain are obviously of glacial origin. The two small glaciers that were responsible for these were derived from the foot of a snow cap that evidently descended to about the 3,000-foot contour. Here the head of the glacier cut into the face of the mountain, leaving a vertical cliff wall seven to eight hundred feet in height. The ice could only have moved out a few hundred yards from the base of these cliffs, and here it dropped the blocks of rock plucked from the cliff faces. These have formed a pair of semi-circular ridges banked two hundred feet or more above the slope of the mountain, behind which the waters of these remarkable hanging lakes are impounded. The glaciers that caused these banks were little more than small extensions of the covering ice cap, developing as the snow level rose towards the close of the glacial age, into a pair of horseshoe or hanging glacierettes. Another small cirque cuts from the south into the saddle connecting the summit of La Pérouse and Maxwell's Ridge.

The largest glacier in the district occupied the great gorge of the Catamaran, between La Pérouse and Leillateah. (See Plate VIII., Fig. 1.) The floor of this, at an elevation between 1,000 and 2,000 feet, was certainly covered by a glacier and exhibits the characteristic features of wide U section, truncated spurs and steep, straight sides. It probably did not fill the valley, but was fed by numerous tribu-

taries, the heads of which can be seen in the numerous minor cirques that make up the head of the main valley. This valley terminates in a grand cirque, consisting of many bays with the more prominent projections flanked by cliffs many hundreds of feet in height. On the south side of the valley cut out of the eastern spur of Leillateah are two fine tributary cirques which hang at a considerable height above the bed of the Catamaran. From the top of La Pérouse you look straight into them. In the western one lies a considerable lake, evidently dammed by a moraine. The greater length of this lake lies at right angles to the slope of the hillside, not an unusual feature with lakes so formed (e.g., Lake Belton).

To the west of the saddle connecting Maxwell Ridge and Leillateah is another great cirque drained by the Picton, and which, cutting into the connecting saddle from the side opposite to the cirque just described, has reduced it to a razor-backed col. In the upper levels of both the Catamaran and the Picton cirques are a series of minor cirques which still further reduce the col and have considerably reduced its height. They are separated by bays on their inner side but coalesce to form a very appreciable ledge on both sides of the col, from which step the cliffs of the larger cirques descend. On this ledge above the Catamaran cirque and reposing under the northern face of Leillateah are two pretty tarns, evidently rock basins, separated by a high ridge of glacial débris, evidently a medial moraine, that can be traced some distance into the major cirque below. On the western side of the col one of these small cirques has been formed between the two diabase prominences, mentioned before, in the centre of the saddle, probably dividing an original single mass into its existing pair of peaks. In this cirque lies the lake, already mentioned, in which the specimens of *Spærium* were found. After a narrow shelf immediately west of the lake the ground drops precipitously to the Picton cirque below. (See Plate VIII., Fig. 2.)

Four of these higher level cirques have cut into the faces of Leillateah, giving the peak its shape, and the buttress spurs described earlier are the residual divides between these cirques. The walls of one form the northern face that the mountain opposes to La Pérouse, and materially contributed to the formation of the shelf and lakes above the Catamaran cirque. A second from the north-west is responsible for the cliffs on that side of the summit that drop

in a succession of precipices to the Picton Valley close below. Between these a low divide runs from the summit to the saddle connecting the mountain with Maxwell Ridge, the divide between these upper cirques and the saddle between the major ones below being part of the same feature. To the south the widest cirque of the four gives the mountain a square face to the sea, and the divide between this and the north-western cirque circles round the head of the Picton to Mt. Wylie, with its crest two thousand feet below the summit of Leillateah. To the east a glacier rose in the fourth cirque and extended for two or three miles over the elevated plain between the eastern and south-eastern spurs of the mountain. It strewed morainal matter over this plain, and behind banks of this the four considerable lakes and several tarns mentioned before have been dammed up.

West of the Picton Valley numerous hanging cirques can be clearly distinguished cutting into the eastern face of Mts. Wylie, Victoria Cross, and Bisdee. Several fine amphitheatres, ringed with sandstone cliffs, can be seen on that range, and an elevated glacial ledge exists there as well as on the Pérouse Range. Ice clearly descended into the head of the Picton Valley, but to what extent or how far it reached could not be ascertained from the mountain top.

(c) Contributions to Tasmanian Glaciology.

In the La Pérouse Range we have an elevated plateau, largely of the same rock and with a uniform opportunity throughout for the development of glaciers and their characteristic topographical forms. We find that during Pleistocene times glaciation developed here to an extent to which the geographical position of the range would lead us to expect. Glaciers occupied the upper reaches of pre-existing stream valleys, moulding them into the typical glacial landscape but not materially affecting the drainage of the pre-glacial country side.

There is ample evidence of an early ice cap stage in the smooth contours of the tops of the ridges. (See Plate IV., Fig. 1.) From the foot of this cap ice pushed down the valleys. The level to which it reached was not ascertained on the trip during which these notes were made, but in the two largest glacial valleys, those of the Lune and the Catamaran, ice probably pushed down to within 1,500 feet of sea level and perhaps to a much lower level in the case of the latter. This is a thousand feet lower than the level glaciers reached

on Mt. Field and Cradle Mountain. Latitude and the greater precipitation over this part of Tasmania will fully account for this. Further evidence of the elevation of the foot of these glaciers would be welcome, and could be best collected by working west from Catamaran township.

At the head of these glaciers, fine cirques have been formed. These are all in the stages of adolescence. They have cut so deeply into the mountain mass that the original plateau has been reduced to a series of twisted ridges. They have, in fact, removed the entire interior of the plateau, and reduced the divides to narrow ridges. In all cases they have commenced to extend their heads laterally and are more or less nail shaped, and in a few cases they have attacked the dividing remnants of the original tableland, but neither of these processes is at all far advanced. The stage of glacial erosion reached is that of the adolescent early fretted upland, similar to that reached on Mt. Anne and Mt. Field.

In one place, a pair of cirques have eroded their divide into a splendid comb ridge. (See Plate III., Fig. 2.) This occurs where the divide is composed of diabase which is sufficiently hard to respond to this form of erosion. It seems that the soft sandstones will not weather into this rugged figure, even when the conditions of the ice flows are suitable, but erode with an even skyline. The "Comb Ridge" is the best example of this feature yet seen by the writer in Tasmania.

Here, as elsewhere, small glacial "monuments" have commenced to appear at the entrance to the cirques, especially Mt. Hippopotamus and the summit of La Pérouse, respectively north and south of the South D'Entrecasteaux Cirque, the process here being assisted by the existence of the belt of hard diabase. (See Plate VI., Fig. 1.) The writer again stresses the view advanced in his previous paper (Lewis, 1923) that the cycle of glacial erosion does not progress in the order its greatest exponent, Professor W. H. Hobbs, appears to indicate, viz., first the formation of a channelled upland, and, when this is completed and erosion still continues, to the fretted upland, then, when this stage is reached, to the monumental upland. But it seems to the writer that from the earliest development of the cirque the incipient monuments commence to appear. Later, as the cirques erode the hinterland these monuments increase in topographical importance until they alone persist after the rest of the

plateau has disappeared. Every feature that in full maturity will be a glacial monument commences to show itself from the earliest stages of the glacial erosion, so at any particular stage of the incipient features all of the later stages can be traced.

Leillateah is one of the best examples of a glacial "horn" to be seen in Tasmania. (See Plate VIII.) Four cirques have attacked what was probably a pre-glacial hill. The divides between these cirques have been reduced to low level (relatively) cols, and the mountain now rises as a regular concave-sided pyramid. This result, however, is due to four independent cirques attacking an isolated mountain rising above the general nivation level and is not a residual of a plateau lying at the heads of cirques which have removed the rest of the surrounding rocks, a difference, however, which is merely one of degree.

It is most noticeable in this area that the cirques have grown in every case from the sheltered side of the main ridges or have been sheltered by some feature on their weather side. In Tasmania the weather comes from the west. The high winds swept the snow from the western slopes of the mountains, and only on the sheltered eastern, northern, or southern sides could it accumulate sufficiently for cirques to grow. As they grew this influence was intensified. This is true throughout the island, and for this reason the western side of any of our mountains or ridges is less rugged and broken than the eastern, and it is on the eastern where we look for cliff scenery.

Here, as elsewhere, there is ample evidence in every direction of two "phases" of the Pleistocene Ice age. (The writer prefers the word "phases" rather than periods, for the present, until evidence is forthcoming of the existence of an inter-glacial epoch.) Most of the larger cirques have minor ones carved in their walls at a height of 500 to 1,000 feet above the floors of the main cirques. (See Plate VI., Fig. 2.) In many places a definite high level ledge runs for a considerable distance round the mountain, and most, if not all, of the lakes on this range, and the outstanding form of Mt. Leillateah, are the result of the second phase. The nivation layer during the very long period when these upper cirques were eroded stood at about 3,000 feet above sea level, a thousand feet lower than it stood on Mt. Field during the

same phase. Evidence of a phase earlier than the one responsible for the major cirques must be sought at the base of the mountain.

One further discovery must be recorded. Right under the eastern edge of the summit of La Pérouse, about 3,700 feet above sea level, is a ledge about a hundred yards wide. On this lies a persistent summer snow bank. This snow bank evidently in winter time, when it would be greatly augmented, moves a few yards down the gentle slope of the ledge. As it passes over the corrugations of the various beds of strata of soft coal measures it has scratched the rock with the fragments it has torn from the adjacent cliff face. The whole length of this ledge shows these very typical glacial scratches, many of which are of so recent origin that they must have been done last winter, and none could have persisted for many years. These scratches are of various ages, many of older date having been crossed by more recent ones, and apparently the scratching is repeated each winter. For further proof the writer scraped some snow away from the foot of the bank and found the process continuing there. This is the first report of an actually proceeding erosion from nivation in Tasmania. It is interesting to note that Lady Franklin records the existence of this snow bank in December, 1838, and it is shown in a photo. taken by Mr. E. Maxwell in December, 1897.

4. ECONOMIC POSSIBILITIES OF THE DISTRICT.

These are very few. The soil of the valleys and the northern ridges, especially towards Adamson Peak, is deep and good, and could provide excellent mountain pastures in summer time, but land hunger must become acute in Tasmania before its use as such could be advocated. To the west the Picton Valley is one of our considerable reserves of farming land, but the chief means of access must be by way of the Huon Valley. In time it will be absorbed into the settled areas of Tasmania, but with so much of our cleared and easily accessible country barely used no one could advocate for the present the expenditure of the large sum necessary to open it up. It has considerable timber resources, but these have been greatly wasted by fires.

No hope of the existence of coal can be held out. Probably any seams that once existed have been removed by erosion, and if any lower measures are found they will prob-

ably be so dissected that the bulk has gone. No sanguine promoter need think that, if the writer's surmises as to recent land movements are correct, there is a hope of oil. These movements are not of a nature to hold out any expectation of the formation of oil, and if it had been formed the erosion of the cirques would have long since tapped any possible reservoirs. These Trias-Jura sediments definitely do not bear commercial minerals.

If the Catamaran collieries ever flourish, the ranges, especially the lakes east of Leillateah, should be examined as potential sources of hydro-electric power. This is a highly glaciated region, and it is such that usually provide the terrain for such schemes. If the reserves of water and suitable sites for dams are present, the other conditions for a small hydro-electric scheme exist.

The greatest future for the mountain will lie in its scenic assets. It is one of the finest areas of mountain scenery in Tasmania, and would provide less difficulty for the construction of a suitable road than most of our mountains, but without a road it is closed to the people from whose interest the State would derive the greatest benefits.

5. APPENDIX.

(a) Explanation of Plates.

Plates I. and II.—Maps of La Pérouse region.

Plate III., Fig. 1.—This shows a typical example of the flake weathering of the sandstone on the top of the ridges, effected mainly by frost and wind. The photo. was taken about 300 yards S.W. of the trigonometrical station at an altitude of 3,800 feet.

Fig. 2.—This is a view of the Comb Ridge, taken looking east from the ledge at the head of the South D'Entrecasteaux Cirque. The rock is diabase. The photo. shows the smoothed surface where the glacier has polished the side of the cirque and the jagged crest which protruded from the ice and was eroded by severe nivation.

Plate IV., Fig. 1.—This was taken from No. 1 hill on Sandstone Ridge, looking south. The first ridge is Tabletop, with the connecting spur to Mt. Hippopotamus behind. The summit of La Pérouse stands

in the centre of the background with the east of Maxwell Ridge to its right and Leillateah in the right background. The Comb Ridge appears end on in front of La Pérouse. This photo. shows the "karling" effect of the cirque erosion on the plateau.

Fig. 2.—This is a photo. of the cirque wall of the Lune Cirque taken looking south from the north-western spur of No. 2 hill of Sandstone Ridge. Across the horizon is Moore's Bridge. Mt. Wylie shows in the right background.

Plate V., Fig. 1.—This shows the north end of Maxwell Ridge, with the cirque at the head of the Reservoir Lakes and the two Reservoir Lakes in the foreground. Leillateah shows in the left background.

Fig 2.—The rock bar damming the upper Reservoir Lake. This is solid rock, and not beach.

Plate VI., Fig. 1.—This is taken looking east towards Recherche Bay, down the South D'Entrecasteaux Cirque, with Mt. Hippopotamus on the right and the Comb Ridge on the left, and the conical hill west of Leprena in the middle distance.

Fig. 2.—This is a photo. of the summit of La Pérouse looking south of east from the south of Sandstone Ridge, and shows the glacial ledge at the head of the South D'Entrecasteaux Cirque and the smaller upper cirque. Note also the diabase of the Comb Ridge protruding through the sandstone of the plateau.

Plate VII., Fig. 1.—Leillateah looking S.W. from La Pérouse, looking across the Catamaran Cirque. Note one of the glacial tarns on the side of Leillateah in the middle distance.

Fig. 2.—Leillateah looking south from Maxwell's Ridge. The tarn in which the *Spærium* were found is seen in the middle distance. South-West Cape can be distinguished in the distance on the right.

Plate VIII., Fig. 1.—This photo. is taken looking south of west from the summit of La Pérouse, and shows Maxwell Ridge and the ridge connecting it with Leillateah, then Mt. Wylie and Mt. Victoria Cross in the background, with Precipitous Bluff behind.

Fig. 2.—This shows Precipitous Bluff looking west from the top of Leillateah. The ridge connecting the latter with Mt. Wylie can be distinguished in the foreground. The north end of the lagoon at the mouth of the New River can be seen on the left.

(b) LIST OF WORKS REFERRED TO.

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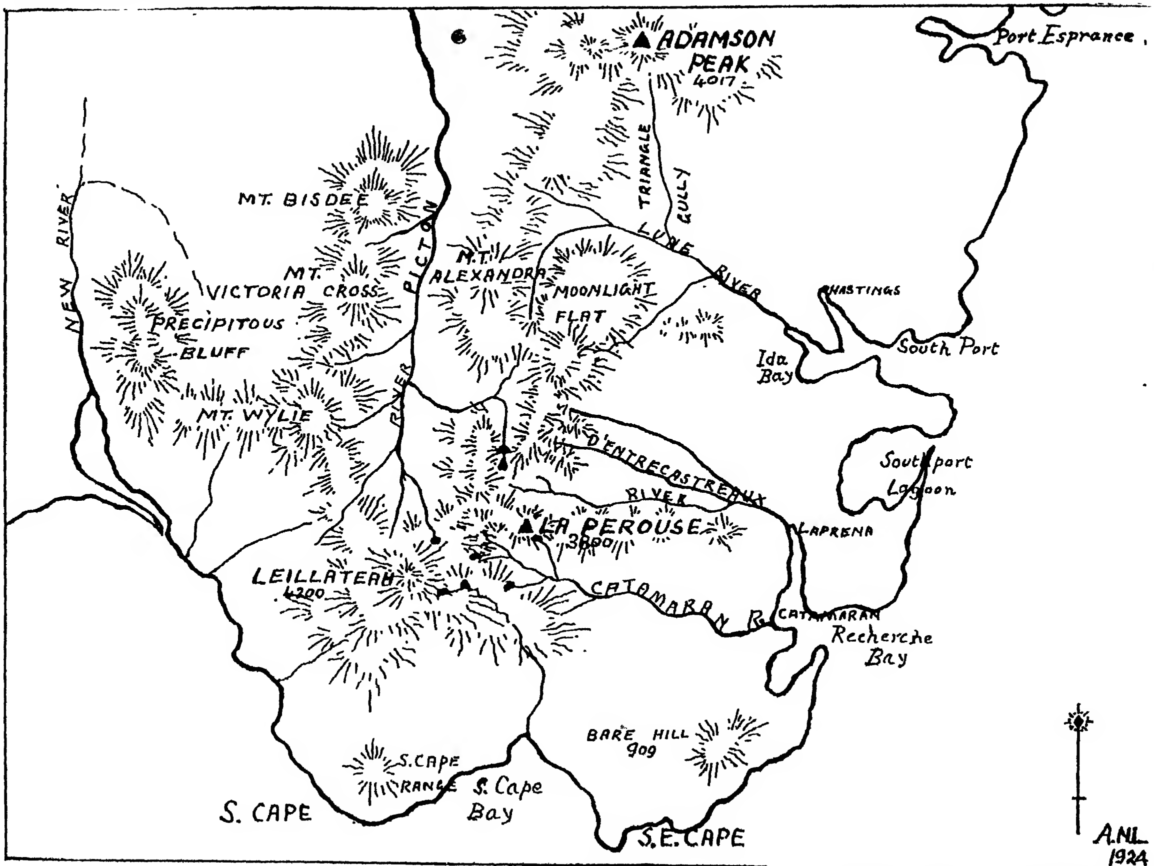
Twelvetrees, W. H. 1915 (i.). "The Catamaran, etc., Coal Field and Limestones at Ida Bay," Geol. Surv. of Tas. Bulletin, No. 20.

1915 (ii.). "Reconnaissance between Recherche Bay and New River," Geol. Survey of Tas. Bulletin No. 24.

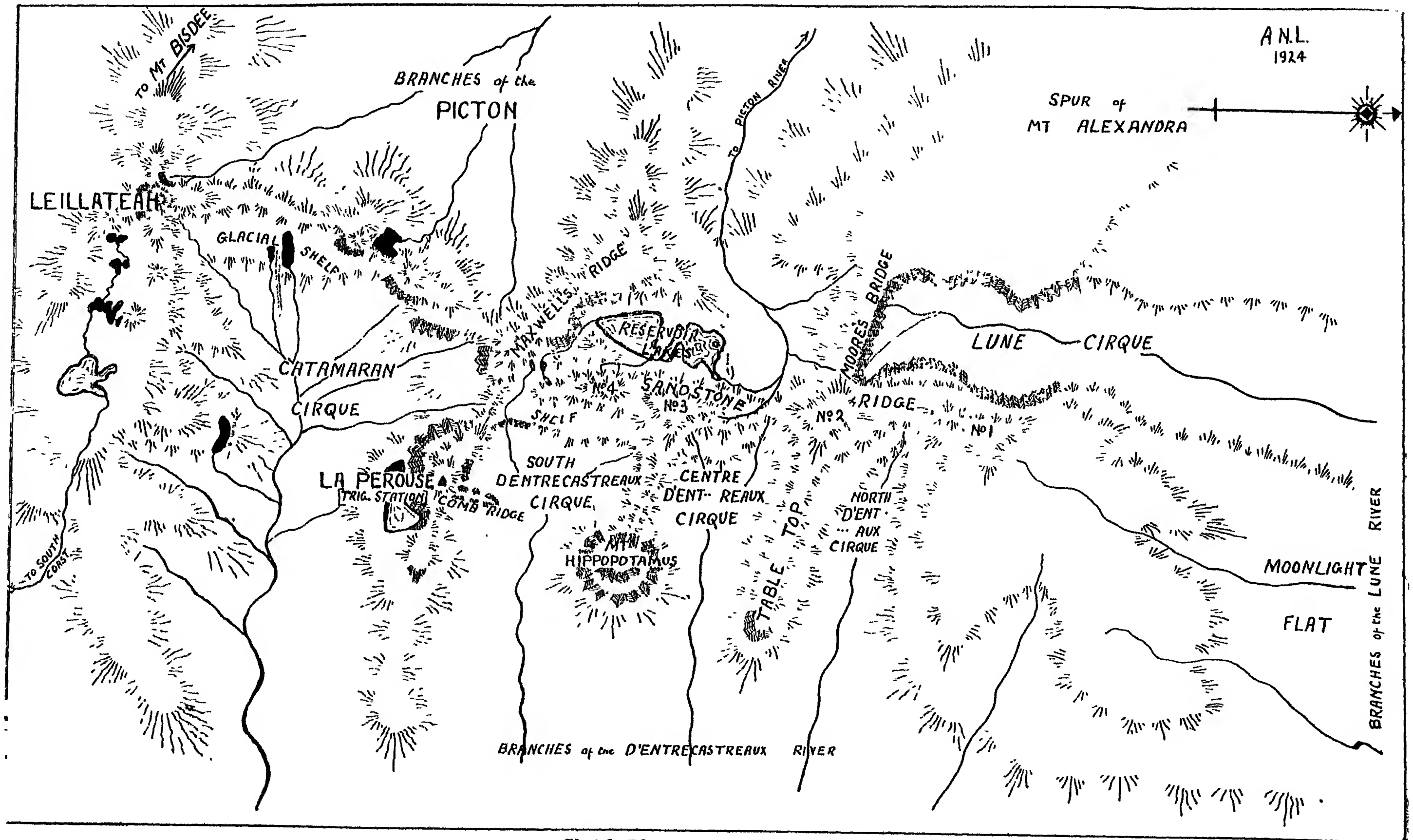
(c) NOTE ON LOW LEVEL GLACIATION AT RECHERCHE BAY.

Since writing the above, the following observations were made on a trip to Catamaran, kindly arranged by Mr. E. C. Tregear.

Two miles west of the shore at Recherche, lies a plain stretching back to the previously described cirques of the ranges. This presents typical glacial aspects, and is so



Locality Plan. Approx. Scale: 1 inch equals 5 miles.



Sketch Plan of La Perouse Range.

Approx. Scale: 2 inches equal 1 mile.

Fig. 1. Sandstone Weathering on Summit of Mt. La Perouse.

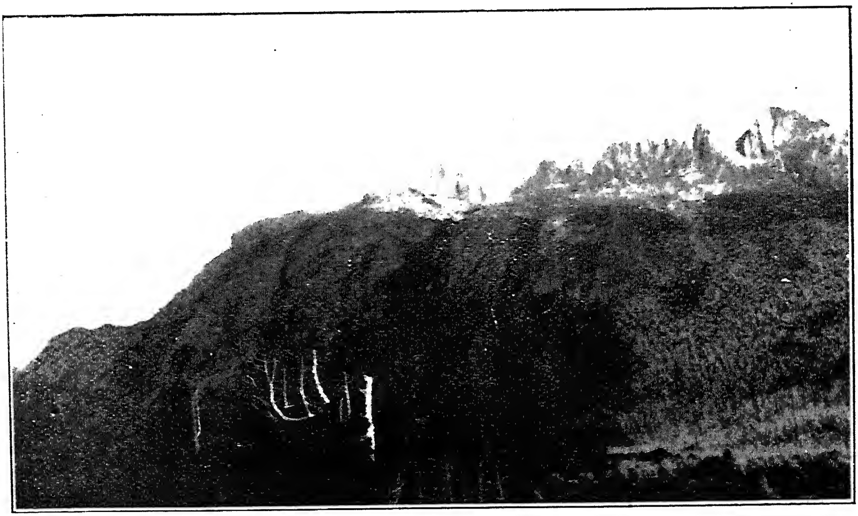


Fig. 2. The Comb Ridge.

A. N. Lewis, photo.

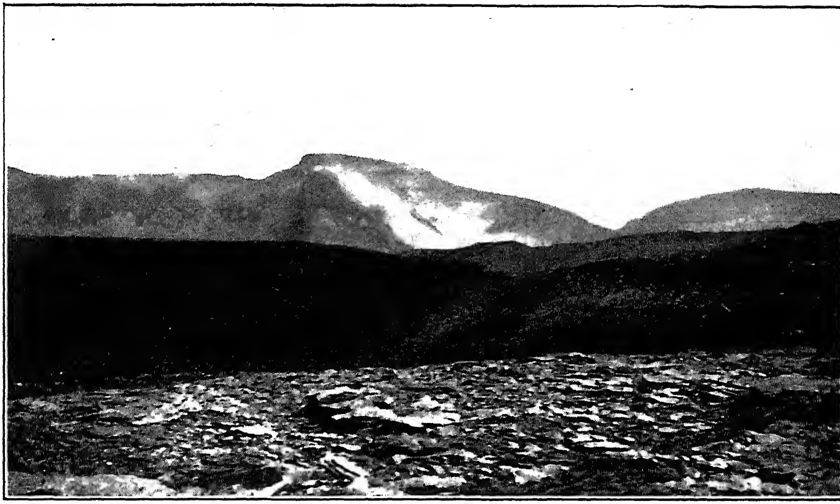


Fig. 1. Summits of La Perouse (centre) and Leillateah (distant right).

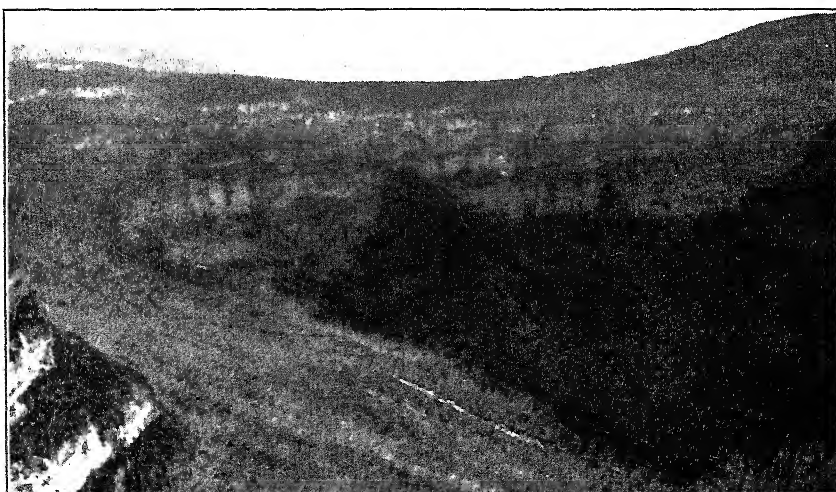


Fig. 2. The Lune Cirque and Moore's Bridge.

A. N. Lewis, photo.

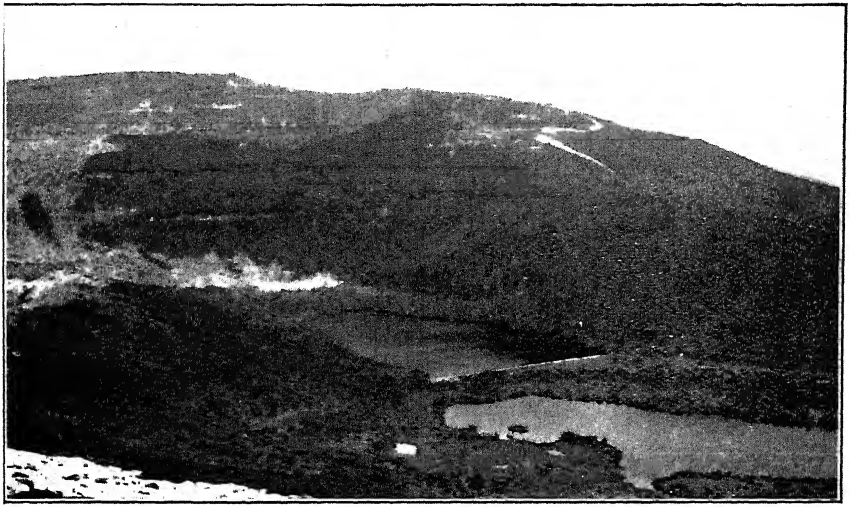


Fig. 1. The Reservoir Lakes.

Fig. 2. The Rock Bar, upper Reservoir Lake.

A. N. Lewis, photo.

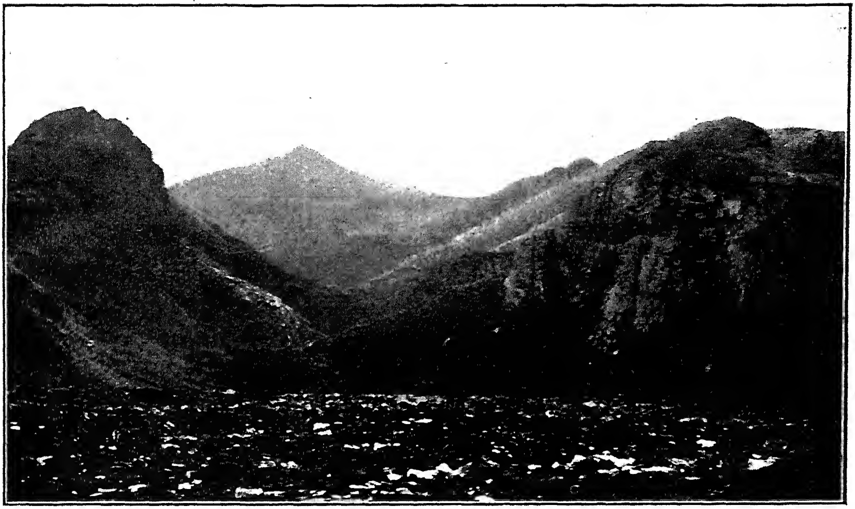


Fig. 1. The South D'Entrecasteaux Cirque.

A. N. Lewis, photo.

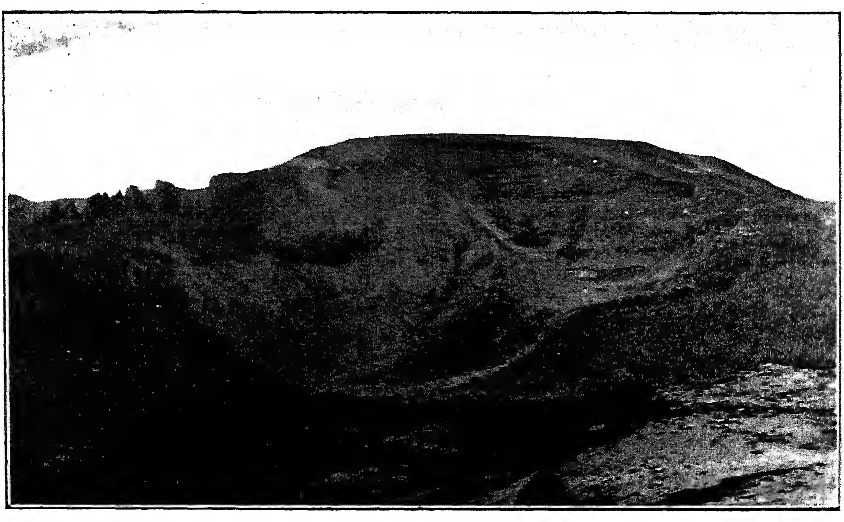


Fig. 2. The Summit of Mt. La Perouse.

Dr. J. Walch, photo.

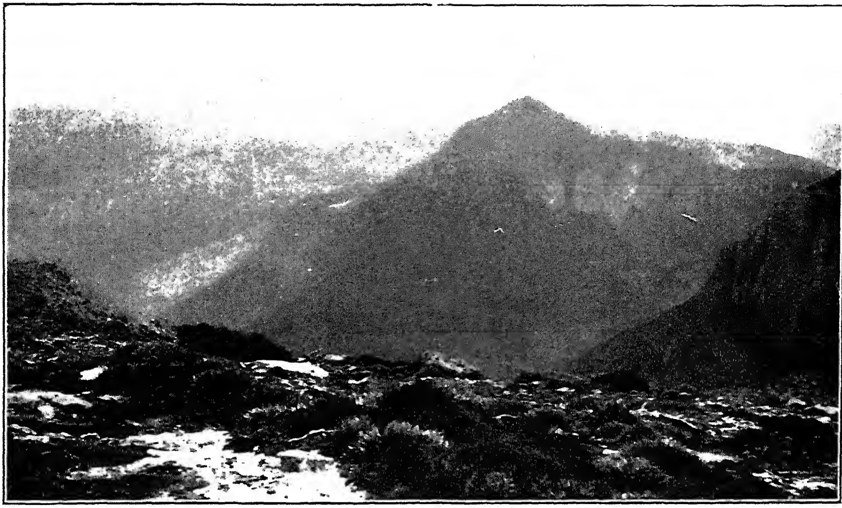


Fig. 1. Mt. Leillateah from Mt. La Perouse.

A. N. Lewis, photo.

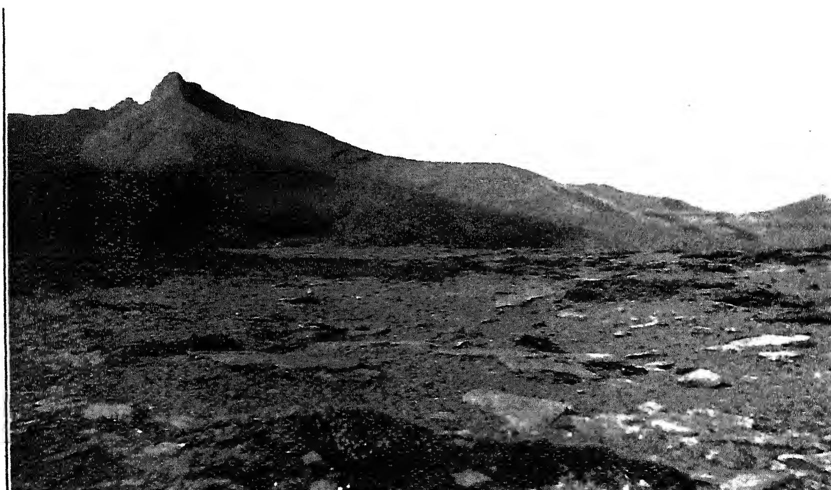


Fig. 2. Mt. Leillateah from Maxwell Ridge.

Dr. J. Walch, photo.

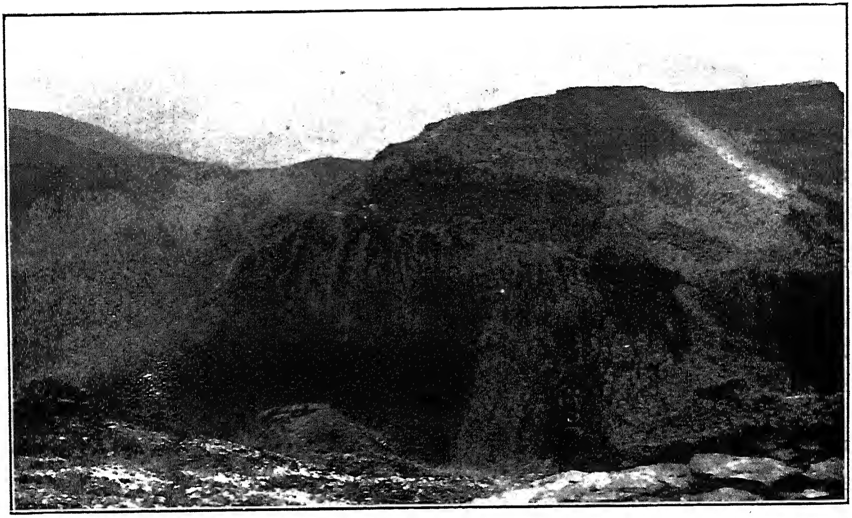


Fig. 1. Maxwell Ridge (foreground), Mt. Wylie and Mt. Victoria Cross (middle distance), Precipitous Bluff (distance), from Mt. La Perouse.

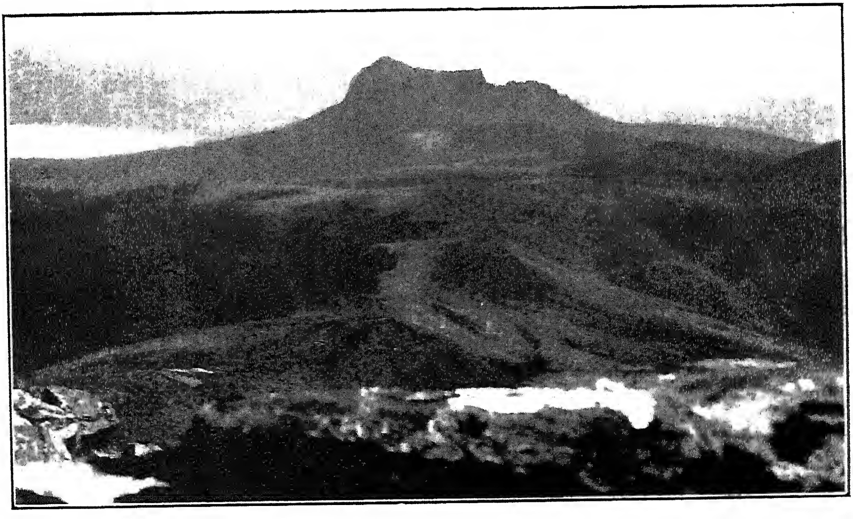


Fig. 2. Precipitous Bluff and mouth of New River, from Mt. Leillateah.

A. N. Lewis, photo.

obviously portion of the same feature as the cirques, that there is no hesitation in saying that it was recently invaded by ice. This brings the level of the ice down to 500-200 feet above sea level. Farther north this plain reaches sea level around the Southport Lagoon. Glacial aspects are not pronounced here, but scattered boulders and indeterminate drainage indicates the former nearness of a melting glacier.

The leases of the Catamaran Colliery Co. are covered with isolated boulders and aggregations of scattered diabase of all sizes, and there are no indications of surface occurrences *in situ* of this rock. They occur on tops of ridges, on steep hill sides, and in swamps, to many of which places no existing stream could have carried them. In many places they present the jumbled appearance of a moraine. These occur from 500 feet to 50 feet above sea level.

Although the bush is so dense that little idea of the details of the topography can be formed, the country just west and south of the old shaft of the Catamaran Mine has all the appearance of typical terminal morainal country. In a cutting on the tramway between the mine and the wharf there are many diabase boulders embedded in clay. These may be residuals of soil erosion, but their lay and the fact that the small parallel fractures do not lie the same way in adjacent boulders indicate that they have been dropped from ice. Just west of Leprena, there is a long ridge, through which the D'Entrecasteaux River has cut, that has the appearance of a terminal moraine. All these indications are below the 100-foot contour.

Joseph Milligan, in his report on "Coal at Whale's Head and South Cape" (Pap. and Proc. Royal Society of Tas., 1849, p. 17), indicates on his sketch and refers to "Rubbishy mixture of Earth with Greenstone and fragments of Stratified Rock." This points to ice action at sea level on the south coast.

[It is not out of place here to refer to the fact that Dr. Milligan there refers to a granite erratic in shale at Southport, and attributes its existence to ice. This would be referable to Permo-Carboniferous glaciation. The reference does not appear to have been noticed by later writers and is, as far as the writer has yet ascertained, the first reference to glacial action in Tasmanian geological literature. The date was 1848.]

The indications seen by the writer on this flying visit are not quite positive, but indicate that ice from the D'Entrecasteaux Cirques reached sea level towards Leprena on the north of Recherche Bay, and perhaps in the vicinity of Southport Lagoon, and that ice from the Catamaran Cirque reached sea level in the vicinity of Cockle Creek, in the south of Recherche Bay. Also that these glacial systems, with distinct sources, were kept separate throughout most, if not all, of their course, by the ridge running east from La Pérouse to the before-mentioned conical hill west of Recherche Bay, which may perhaps be the *Mt. King* of Lady Franklin although there is evidence of a coalescing, during the period of maximum glaciation, to form a narrow piedmont ice sheet for perhaps a mile in front of this hill. The ice that was responsible for the indications here noted was essentially that of an extended valley glacier pushing down from the mountains not five miles away, and keeping to a single defined path, and not in the nature of an ice sheet.

NOTE ON A CLIFF SECTION NEAR CAPE PAUL LAMANON.

By A. N. Lewis, *M.C.*, LL.B.

Plates IX. and X.

(Read 9th June, 1924.)

LOCALITY.

The observations here recorded deal with the two miles of cliffs that lie westward from Cape Paul Lamanon, the extreme north-easterly point of Forestier Peninsula, south-eastern Tasmania, to the "Narrows" at the entrance to Blackman's Bay. They were made during the annual camp of the Tasmanian Field Naturalists' Club, Easter, 1924, and warrant wider publicity than the club can obtain for them.

THE PERMO-CARBONIFEROUS SUCCESSION.

The following tables set out the major stratigraphical systems of this period:—

A. Generalised table of succession throughout Tasmania. (Geol. Survey, 1922, Plate II.)	B. Succession Table in South-Eastern Tasmania based on Writer's Observations.	C. Succession in New South Wales.	(David, 1923.)
6 Tomago Coal Measures. (500-700ft. at Preolenna and Barn Bluff, 200ft. at Cygnet.)	6 Shales, perhaps representing Tomago Coal Measures (50ft.)	Upper Permian	Newcastle Beds. Dempsey Beds. Tomago Coal Measures.
5 Upper Marine Mudstones. (From 50ft. at Preolenna to 500ft. in Upper Derwent and 1,100 feet at Barn Bluff.)	5 Upper Marine Mudstones (500ft.)	Lower Permian	Upper Marine Mudstones. Greta Coal Measures. Lower Marine Mudstones.
4 Greta Coal Measures. (From 50ft. at Barn Bluff to 200ft. at Mersey.)	4 Sandstone, perhaps representing Greta Coal Measures. (25 to 50ft.)		
3 Lower Marine Mudstones. (From 25ft. at Barn Bluff to 400ft. at Preolenna and 1,000ft. at Bruny.)	3 Lower Marine Mudstones. 2 Limestones. Together about 500 feet. In places either one or the other. Where both present, mudstones always above limestones.	Middle to Upper Carboniferous.	Kuttung Series Glacial Stage. Kuttung Series Volcanic Stage.
2 Limestones. (Not always present or distinguishable from 3. Maximum development 550 ft. at Maria Island.)			
1 Basal Conglomerates. (Not always present. In many places base obscured. Maximum development 1,200ft. at Preolenna.)	1 Basal Conglomerates. (Base obscured.)	Lower Carboniferous.	Burindi Series.

The Basal Conglomerates are the series affected by the observations here set out. "The Carboniferous system proper "is absent [in Tas.], the lowest bed of the sedimentary sys- "tem consisting of the basal conglomerates of the Permo- "Carboniferous. These conglomerates constitute the base "of the Permo-Carboniferous wherever they occur in Tas- "mania. . . . . Conformably overlying this basal conglomerate "is the Lower Marine Series." (Geol. Survey, 1922.) It is universally recognised that these conglomerates are of glacial origin, and they vary from a tillite to a mudstone containing ice-dropped erratics in varying quantities. "There are at "least three, perhaps four, distinct tillite horizons, and these "are separated from one another by strata perhaps repre- "senting inter-glacial epochs. Each tillite horizon can be "correlated certainly with those of Victoria, and almost cer- "tainly with those of South Africa [Dwyka conglomerates "of the Karroo system], and these are succeeded by marine "strata belonging to the Lower Marine series." (David, 1914.) In New South Wales the glacial beds are considered to represent the division between the Carboniferous and the Permian periods, although they are now classified as Upper Carboniferous. The succeeding series are developed in remarkably parallel lines in both States. The stratigraphical position of the glacial beds is therefore the key to the problem of the separation of our Carboniferous and Permian rocks.

THE SUCCESSION AS DISCLOSED NEAR CAPE PAUL LAMANON.

The important observation here recorded is that in the cliff section referred to, the glacial conglomerates overlie and unmistakably succeed beds of limestone containing abundant fossils of species ordinarily referred to the Permo-Carboniferous period. and in the glacial beds above was found a boulder of limestone containing such typical fossils.

GENERAL DESCRIPTION OF THE BEDS.

Cape Paul Lamanon and the next succeeding headlands to the southward are residuals of diabase left by coastal erosion of intervening sedimentary rocks since the earth movements that gave the coast its general outline. The above-mentioned cape is a low, sharp pointed headland from which the coast extends for three-quarters of a mile to the

south-west to Prince of Wales Bay, at the head of which stands Tasman's Memorial, and for two miles or so to the westward to Chinaman's Bay at the "Narrows." A coarse gabbro-like diabase (dolerite) extends from the extremity of the point westward for about three hundred yards, and is then succeeded by Permo-Carboniferous sedimentary beds which quickly rise to cliffs 200 feet high and extend westward for nearly a mile to a deep cove, the drowned terminal of a steep gully. Westward of this they rise sharply again to a cliff face nearly 100 feet high and gradually drop to sea level half a mile farther west at the "Narrows." A small cliff face thirty feet high runs from the western side of Chinaman's Bay for a few hundred yards farther west. These sedimentary rocks have a decided and uniform dip of 10 degrees to the west. At the base of the cliffs runs a well defined shore platform.

The diabase of the extremity of Cape Paul Lamanon has greatly disturbed the adjacent limestones. For a hundred yards from the point of contact, which is obscured, the limestones have been metamorphosed and indurated, more or less, according to their proximity to the igneous intrusions and especially along certain layers which now stand out brown in colour and particularly hard. The original fossil organisms which abounded in the limestones are still preserved in its metamorphosed state. In addition to this effect, the intruding diabase has crushed the limestones for fifty yards from the contact into a tiny anticlynora consisting of several small folds increasing in size to a central anticlyne with a radius of twelve feet, and broken by a wide fissure. This is succeeded by a succession of diminishing folds until the strata merge into the normal dip of the rest of the beds. In addition to these folds the whole crushed zone is bent into a broad but perceptible arch. The folds nearer the diabase show a tendency to overturn, the pressure evidently coming from the direction of the diabase and slightly upward. The writer is of the opinion that this slight folding has been caused by the diabase intrusion, and not by pressure from the west against the diabase as a *remanier block*. This contortion is a very unusual feature in these rocks, and indicates considerable depth at the time of the intrusion, which has obviously not raised this particular section to its present height.

At their eastern extremity these beds consist of limestones exposed at sea level. On the top of the cliffs a little

farther west the beds consist of glacial conglomerates. Here the junction cannot be easily ascertained, but the dip of the strata brings this junction down to sea level at the cove mentioned above, half-way between the Cape and the "Narrows," and this interesting section can be seen with ease. On the west side of this cove, limestones dipping as mentioned before are exposed at sea level. These beds consist almost entirely of fossil remains, amongst which *Spirifera vespertilio*, *S. tasmaniensis*, *Strophalosia clarkei*, *Productus brachythærus*, *Fenestella*, *Protoretepora*, and *Stenopora* predominate, and closely resemble the limestones of Granton, Glen Lusk, and elsewhere. A specimen of *Stenopora crinita*, displayed in the Hobart Museum, was collected from this spot by Mr. R. M. Johnston, who has appended a note to its label to the effect that it was the best specimen he had ever seen. They dip below sea level at a point about fifty yards west of the north-western corner of this cove. Succeeding these limestones, with a sudden break, but without trace of disconformability, come two feet of coarse sandstones devoid of fossils except occasional casts in the lower bands. This sandstone merges into the glacial conglomerates above.

The glacial conglomerates are typical of these beds, which have been too well described elsewhere to require a further account. (See e.g., Peppermint Bay, Hogg, 1901; Wynyard, David, 1908; South Cape, Twelvetrees, 1914; Maria Island, Clemes, 1916; Weld River, Lewis, 1923.) In a few spots they approach a tillite, but generally they are a hard mudstone studded with small fragments of quartzite, granite of all descriptions, schist, and slate, with occasionally some much larger blocks. They persist westward from the point mentioned and comprise the outcrops west of Chinaman's Bay and the rock of the hills inland on the track to Tasman's Memorial. The length of the exposure along the line of dip is in the vicinity of 5,000 yards, which with a dip of 10 degrees gives a thickness of at least 800 feet. But nowhere does the original top of the glacial conglomerates remain. This is the greatest thickness for these beds yet recorded in south-eastern Tasmania, and it is evident that they were originally much thicker.

The last observation in this locality bearing on the question of succession, was the discovery of a block of limestone containing fossils ordinarily referred to the Permo-Carboniferous period, embedded in the glacial beds. East of the "Narrows" the first cliffs are low, considerably eroded,

and skirted by a beach of large sea-worn boulders. These are succeeded in a couple of hundred yards by an insignificant identation where cliffs give place to a steep earthy slope. West of this the beach boulders give place to a smooth wave-washed rock platform from which the cliffs rise perpendicularly for 80 feet, the eastern edge of these cliffs forming a buttress. The limestone boulder under discussion is embedded in this cliff about 30 yards east of this buttress and six feet above the shore platform. It consists of a hard, almost crystalline, blue limestone, roughly spheroidal in shape, and about a foot in diameter. It is impregnated with remains of *Fenestella internata*, and there is a splendidly preserved specimen of *Spirifera vespertilio* or *convoluta* with both valves complete exposed on its under side. It had been weathered round its outer surface for a depth of two inches prior to its deposition in the glacial beds, and this weathered zone is softer and shows a different colour from the core, but is impregnated with similar fossils. The boulder has obviously been dropped in mud, and the strata now show bending beneath it and squeezing around it at the sides.

BEARING OF THESE OBSERVATIONS ON THE PERMO-CARBONIFEROUS SUCCESSION.

These observations make it clear that here at any rate an epoch of marine conditions, during which forms of life typical of the Permo-Carboniferous of Tasmania flourished, was followed by a long epoch of glacial conditions, and that limestone of this age had been consolidated into a hard rock before the succeeding glacial epoch was half advanced. This forces on us the conclusion that the glacial beds do not necessarily represent the base of the sedimentary rocks of the Permo-Carboniferous-Trias-Jura period.

Perhaps this limestone is merely a local variation such as are frequent throughout these beds. If this is the case the ice responsible for the glacial beds must have been local or glacial in origin, and not universal or in the nature of an ice-cap. In any case this explanation, although a possible one, has no grounds to support it.

If the glacial beds represent the true base of the Permo-Carboniferous (or the Permian) in Tasmania, these limestones would be relegated to the Carboniferous. Of course one isolated section is insufficient alone to warrant such a change in our accepted classification.

The explanation that commends itself to the writer is that glacial conditions continued with great local variations well into the time occupied by the deposition of the limestones and lower marine mudstones—a conclusion supported by several observations around Hobart—and that the limestone here observed indicates one of the interglacial epochs corresponding with those identified by Sir Edgeworth David at Wynyard (see *supra*).

This section at least teaches us that when working downward through the Permo-Carboniferous rocks we cannot say we have reached the base of the system when we reach the glacial conglomerates. Careful search should be made to see if this order of succession is followed in these beds elsewhere.

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Lewis, A. N. 1923. "Reconnaissance of Mt. Anne and the Weld River Valley," Pap. and Proc. Royal Society of Tas., 1923, pp. 21-22.

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Fig. 1. Contorted Limestones of Permo-Carboniferous age near Cape Paul Lamanon, S.E. Coast, Tasmania.

A. N. Lewis, photo.

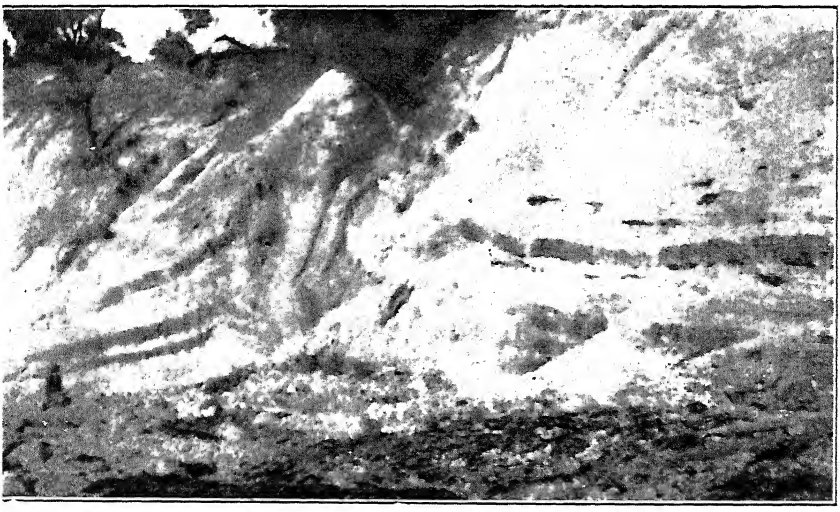


Fig. 2. Contorted Limestones near Cape Paul Lamanon

A. N. Lewis, photo.

Fig. 3. Boulder of Permo Carboniferous Limestone included in glacial conglomerate of same period. A. N. Lewis, photo.

Fig. 4. Cliffs near "The Narrows," Marion Bay, S.E. Coast, Tasmania, looking west. Limestones appear at sea level towards left of picture, and are succeeded by glacial conglomerates. A. N. Lewis, photo.

ADDITIONS TO THE FISH FAUNA OF TASMANIA.

By Clive Lord, F.L.S.

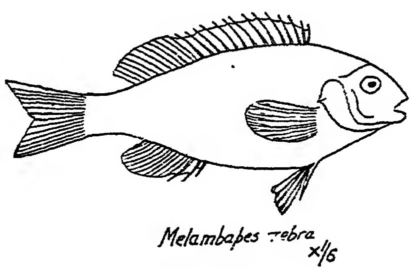
(Director of the Tasmanian Museum).

(With two Text figures.)

(Read 10th July, 1924.)

In addition to the previous records published (P. & P. Roy. Soc. Tas., 1922 and 1923), it is desired to add the following species to the Tasmanian faunal list. There are, no doubt, many more yet to be added before the Tasmanian list can be considered complete, especially as regards the deep water forms. For several reasons it is considered advisable to note additional species as they occur, and the following are therefore recorded in the present instance.

Melambaphes zebra, Richardson.



(Zebra Fish.)

Crenidens zebra, Rich., Zoo. Er. & Terr., p. 70 (1846).

Tephraeops zebra, Gunther, Cat. Fish Brit. Mus., I., p. 432 (1859).

Girella zebra, Steindachner, Sitzl. Akad. Wiss. Wien, III., p. 430 (1866).

Neotephrocops zebra, Castlenau, P.R.S. Vic., I., p. 69 (1872).

Melambasis zebra, Castlenau, P.R.S. Vic., II., p. 42 (1873).

Tephraeops zebra, Waite, Rec. S.A. Mus., p II., pl. 14, fig. 175 (1921).

Melambaphes zebra, McCulloch, Fish & Fish-like Animals of N.S.W., p. 63 (1922); Waite, Fishes of S.A., p. 137 (1923).

Order *Percomorphi*. Family *Girellidæ*.

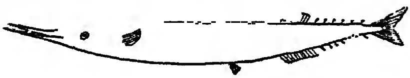
D. 14/13-15; A. 3/11; P. 18; C. 17.

Brownish olive above merging into lighter colours on under surface. The body covered with nine dark bands. Length, 300 mm.

This species has been obtained from the East Coast of Tasmania, and it is strange that its occurrence there should have been overlooked. The zebra-like stripes give rise to its vernacular designation.

This species is occasionally referred to as a "Black Bream" by fishermen, but it should not be confused with *Girella tricupidata*, from which it may be distinguished, apart from other characteristics, by the scaly operculum, smaller scales, and by having about 80 scales on the lateral line.

Scombresox forsteri, Cuvier & Valenciennes.



Scombresox forsteri ×1/6

(Billfish or Skipper.)

Scombresox forsteri, Cuv. & Val., Hist. Nat. Poiss., XVIII., p. 481 (1846); Waite, Rec. S.A. Mus., Vol. II., p. 64 (1891); Fishes of S. Aus., p. 88 (1923); McCulloch, Fishes and Fish-like Animals of N.S.W., p. 29 (1922).

Scombresox saurus, var. *forsteri*, McCoy, Prod. Zoo. Vic., pl. 135, fig. 2 (1887).

Order *Synentognathi*. Family *Scombresoxidæ*

D. 10, VI.; A. 11, VII.; V. 6; P. 12; C. 20.

Length 300 mm.

The extension of both jaws, together with the detached finlets behind the dorsal and anal fins, serves to immediately distinguish this species from the Garfish (*H. intermedius*).

Tasmanian examples have been secured from the Derwent.

STUDIES IN TASMANIAN MAMMALS, LIVING AND EXTINCT.

No. XII.

ON CERTAIN TASMANIAN PLEISTOCENE MARSUPIALS.

By

H. H. Scott, Curator of Launceston Museum,

and

C. E. Lord, F.L.S., Director of the Tasmanian Museum, Hobart.

(Read 10th July, 1924).

INTRODUCTION.

These notes clear up an apparent contradiction between the writings of Lydekker (1889) and De Vis (1884). They explain the real size of the Giant Wombat in terms of Professor Owen's original conception of its dimensions, and show why later workers, upon such remains, were naturally misled (Scott, 1915). They supply some data respecting the Nototherian animal called *Nototherium tasmanicum*, and add to our knowledge of the variation in the premolars of the species *N. mitchelli.* The notes have been culled from two separate "finds" recently made at the Mowbray Swamp, and are directly associated with the names of Mr. and Mrs. K. M. Harrisson and Mr. E. W. Reeman.

From tooth marks found upon one bone we again stress the former existence in Tasmania of powerful carnivorous animals, but to date of writing this, their remains have not been recovered.

PALORCHESTES AZAEL (?) (OWEN).

PALORCHESTIA PARVUS (?) (DE VIS).

The fragments of this gigantic macropod that have recently come to light do not justify the accurate specific determination of the specimens. If we follow Lydekker, and

agree to admit but one species for the genus, then the specific name *Azael* covers all the remains referable to these gigantic kangaroos. De Vis (1894) when reviewing the fossils in the Queensland Museum created a new species, namely, *Parvus*, which he claimed stood to the type, in the same relationship that *Sthenurus outeul* did to *Sthenurus goliah*. As De Vis's determinative generic characters are more workable than those finally adopted by Lydekker, and his whole paper is carried out to extreme detail, his contention that more than one species existed is here admitted, although our specimens are too imperfect to relegate to either with absolute certainty.

MANDIBLE.

Parts of the right and left rami of the mandible are present, but in neither are the coronoid processes, or more than an inch of the symphysis.

CHEEK TEETH.

We are fortunate enough to possess a right upper maxillary of a *Palorchestes*, with four teeth *in situ*, that came from the Mowbray Swamp, and has already been figured and described (Scott, 1915). This specimen enables us to compare a serial tooth line with the detached teeth that are now in process of description, and when this is done it is easy to reconcile the contradictory statements of Lydekker and De Vis. The fact is, the teeth start by having anterior and posterior talons, and then can even be traced in old teeth—if the latter are available for examination—as separate moieties; but under the mutual pressure of a forwardly thrusting dentition (as is known to exist in the *Macropodidæ*) they become obscured and so justify Lydekker's statement when the teeth are examined in position in the jaw. With our more perfect specimen we can compare a right upper molar No. 3 from the material just to hand, and exceedingly welcome the latter is, as it adds a note as to a missing crest from our former specimen. This tooth may thus be described—Total length 26 x 20 mm. Crests but slightly worn, height of enamel surface, to top of crest, 16 mm., pre-basal and post-basal ridges, the former being the larger of the two. The connecting link is central and the two equal valleys are open and quite *unclosed*. The enamel is punctate especially upon the posterior surface. This almost unworn tooth is nearly 4 mm. taller than the same molar in our former specimen, thus indicating the amount of wear that went on in the dentition of these ancient animals.

The remaining fragments of teeth, although listed for comparative work in the future, need not be passed in review in the present communication to the Society.

CLASSIFICATION.

As all our specimens are imperfect, extreme caution is needed in any attempt at exact classification, the more so. as Owen figured and described (Owen, 1874) the premolar of *Palorchestes* as being sub-elliptical, with the contact surface with molar No. 1 not the widest face as obtains in Kangaroos generally. De Vis (*loc. cit.*) figures the premolars, of both species, and describes them as being triangular in the upper jaws, a condition that is duplicated in our first Mowbray Swamp find, and indeed better shown (owing to splendid preservation) than anything elsewhere depicted. This latter specimen suggested, to us, an animal too large for anything but Owen's *Azael*, yet *Azael*—as Owen knew it—had premolars of a different type altogether, so evidently we have yet much to learn respecting the dentition of these mighty animals. Our second specimen has no premolars, but in a general way agrees with De Vis's *Parvus*, and so provisionally we leave it under that taxonomic heading, and await other parts of the skeleton to ultimately determine the outstanding problems. Owen's specimen is too perfect to allow any element of uncertainty, and so are those described by De Vis, and yet they do not fall into line, and nothing short of a series of such remains will meet the needs of the case.

THE GIANT WOMBAT.

Phascolonus, Owen.

From the specimens given by the Harrissons we next select a mutilated shaft of a femur relating to the Giant Wombat, *Phascolonus*, this being the second time that a single bone of that animal has reached us from the Mowbray Swamp, and thus attesting to the former existence of that Marsupial in Tasmania. In dealing with this femur we have as comparative data the two fine figures given by Dr. Stirling in his Monograph upon *Phascolonus* (Stirling, 1913), together with some sketches, measurements, and notes supplied to us by Dr. Stirling himself in 1922. Although both of our Tasmanian specimens are devoid of proximal and distal ends, enough remains to make it certain that the Tasmanian animals were larger than those studied in South Australia, a circumstance of interest, as it bears upon the question of the

general size of these extinct animals. Dr. Stirling, working with femora that did not exceed 334 mm., thought the original estimate made by Professor Owen far too high, as indeed it would have been, had the South Australian specimens been average adult size for these animals, in all parts of Australia, which it now seems was not the case. Both of our femora must have been well over 400 mm., and the Buchan Cave femur is apparently another 60 mm. in excess of that estimate, so apparently there were large and small races of these creatures as there are to-day among Wombats, and Owen's statement need not be called in question. Nobody knew better than Dr. Stirling that the Normanville specimen was that of an animal only just finishing growth, and his splendid figure duly illustrates the point, since the line of the trochanter minor is seen to be on a level with the floor of the trochanterian fossa, while in the older Callabonna specimen it is placed higher up, all of which conditions obtain to-day with growing and mature wombats' femora.

In handling the *Phascolonus* bone, last received by us, it became manifest that some marks upon the surface relate to the action of the teeth of an ancient carnivore, a point of some interest to us as it confirms our former statement (Scott and Lord, 1913) made to the Society respecting mutilations to a Pleistocene fossil femur. Our conviction is that these marks were not made by man.

It is our duty to point out that an alteration in our notions respecting the size of *Phascolonus* was almost certain to take place when the true limb bones of *Nototherium* were determined, since all writers upon the subject prior to 1910 were under the conviction that the Nototheria linked the Wombats with Diprotodons, and all extra large phascolonian bones were according relegated to *Nototherium*, while the smaller ones were reserved for *Phascolonus*. The bulk of Dr. Stirling's work upon the Giant Wombat was completed prior to his seeing the true limb bones of the *Nototheria*, and accordingly had he met with femora as long as 420 mm. he would not have readily associated them with *Phascolonus*, hence his estimate of the size of the extinct Wombat. In 1871 Professor Owen stated that some of the bones he had relegated to *Nototherium* might have belonged to a gigantic wombat, but the point was not cleared up until 1910, when a complete skeleton was found in the Mowbray Swamp at Smithton, Tasmania.

NOTOTHERIUM TASMANICUM (SCOTT).

Of the animal called *Nototherium tasmanicum* (Scott, 1910) we have fresh evidence in the shape of parts of the lower jaws of a fully adult creature. The acquisition is due to the kindness of Mr. and Mrs. Harrisson. The right ramus is especially perfect as to teeth, though otherwise very much mutilated, and they work out true to type. The total tooth line from premolar 4 to molar 4 is 162 mm. in both animals, as against 175 mm. for a *Nototherium mitchelli.* These jaws depart materially from *Nototherium victoriæ* and can be separated from them by the following characters:—

1. Dental foramen 25 mm. above molar 4, as against alveolar level in *victoriæ.*
2. Angle slightly inturned and jaws rounded as against angle strongly inturned and lower surfaces of jaws wide and flat.
3. Slight and narrow post alveolar platform as against wide and extensive one in *N. victoriæ.*
4. Tusks sharply rounded in fore and aft direction and strongly upturned, as against an arc of a much larger circle and position in jaws more procumbent in *N. victoriæ.*

All specimens of both species in our possession agree in these details.

5. The astragali of the two animals vary enormously.

NOTOTHERIUM MITCHELLI (OWEN).

A small, but interesting series of remains have come to us from Mr. E. W. Reeman, of Smithton, the find of course relating to the Mowbray Swamp area. The specimens relate to the upper maxillary regions, and give us two absolutely complete tooth lines with the premolars perfect and but recently erupted, indeed, the "craters" have not filled in. In spite of the youth of the animal the tooth line being completed is typical of the species and measures just on 174 mm. as against 175 for the male whose skeleton is in the Tasmanian Museum, Hobart, and 158 mm. for the male of *N. tasmanicum.*

THE PREMOLARS.

As these teeth have just come into position and are unworn, a description of them should be of interest.

R. Premolar No. 4 Antero-posterior length—25mm.
" " Greatest width—24mm.

The working surface of the tooth consists of a large, isolated anterior tubercle, which with its valley accounts for about one-third of the total length of the tooth. Externally there is a single cutting edge that occupies the rest of the length of the tooth upon that side. Exactly in the centre is a raised ridge of enamel, that extends from the cingulum to the crown. Viewed from above, the whole working surface is seen to simulate the five spots of a domino, with the fifth slightly removed from the common centre of the other four. The lingual pair of spots are well marked tubercles and their valleys deeply cut, but the external pair are not seen in a side view of the tooth, but appear as slightly worn spots in the common external ridge when viewed from above.

The left premolar is not the same, since the two lingual tubercles are blended together to form a cutting ridge, their dividing valley being uncut, but indicated by grooves only. Looking upon the working surface of this tooth the last thing one would compare it with, would be a domino, yet its fellow so strongly suggests that simile that we could not but use it. If these two premolars were separated, and their history lost, it would be hard to justify their relegation to a single skull, and the differences would increase as wear took place. This is a point worthy of note.

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NOTES ON A GEOLOGICAL RECONNAISSANCE OF THE LAKE ST. CLAIR DISTRICT.

By W. H. Clemes, B.A., B.Sc.

(With 1 Map and 8 Plates.)

(Read 13th October, 1924.)

SYNOPSIS.

1. INTRODUCTION.

(a) General.

Through the courtesy of Messrs. F. B. Cane and G. L. Propsting, I was enabled to join them in an expedition to Lake St. Clair in the last week of 1923. The Lake St. Clair-Cradle Mt. Districts have recently been reserved as a Scenic Reserve, the lower and larger portion of which, extending from the Derwent Bridge in the south, to the Wallace River in the north, and comprising approximately 94,000 acres, has been placed under the control of the National Park Board,

which has shown its fitness to take on the larger responsibility by the fine work it has already done in the Mt. Field area. Another party under the leadership of Mr. Clive Lord, Hon. Secretary of the National Park Board, and Mr. Rodway, another prominent member, were also camped at Cynthia Bay. Expeditions were undertaken to all places of interest in the vicinity, as time permitted. Much valuable information was obtained of the fauna, flora, and geology of the district, and those of us who were members of the Board were enabled to get a clear insight into its possibilities for tourist traffic.

Evidence to confirm certain theories brought forward in this paper will have to be obtained on some future expedition. A camp situated at the North-Western end of the lake would result in the collection of much valuable information. I would also suggest the obtaining of complete soundings of the lake, as all record of Mr. Charles Gould's work appears to have been lost.

(b) Geographical Position and Access.

Lake St. Clair lies about 120 miles from Hobart, at the source of the River Derwent, and among the outliers from the western edge of the Central Plateau. Mountains surround it on every side. The Traveller Plateau, Mount Ida, and the Du Cane Range lie to the east and north, to the north-west rise Mount Manfred, Mt. Cuvier, and Mt. Byron, whilst Mt. Olympus towers above it to the west. To the south-west and separated by the Vale of Cuvier from the latter lie Mt. Hugel and Mt. Rufus, to the east of which are Bedlam Walls and Mt. Charles. From the summit of Olympus a wonderful panorama is revealed. Behind the Du Cane Range appear the fretted uplands of the Pelion and Cradle Districts, to the west the varied forms of the West Coast mountains, with the smoke of Lyell visible some 30 miles away, to the south-west the never-to-be-forgotten Frenchman, with Mt. Gell and Gould's Sugarloaf for a foreground, and, behind Rufus, across the Navarre Plains, the King William Ranges with Wyld's Crag and Field West in the far distance to the south, across the Vale of Rasselas. The elevation of the lake, as given on the Mines Department Chart, is 2,409ft. (Hydro-Electric, 2,290ft.) Its length is about 11 miles, while the greatest breadth is about 2 miles. A depth of 590ft. has been recorded. Geoffrey Smith writes as follows: "Lake St. Clair is exceedingly "deep, in most places from forty to seventy fathoms, and in "some parts as much as ninety fathoms; the water is ab- "solutely pure, and, owing to the depth, very dark blue or

"black, and of an icy coldness even in the height of sum-"mer."

The road to Lake St. Clair passes through Gretna, Hamilton, Ouse, Dee, and Bronte, crossing numerous tributaries of the Derwent, such as the Clyde, Ouse, Dee, Nive, Clarence, and Traveller. The mail car runs three times a week to the Dee, and once a week to Bronte, which is also in telegraphic communication with Hobart. The old Linda track passed along the site of the present road until crossing the Derwent Bridge about two miles from the lake. It there diverged, passing down the Charles and Navarre Plains to the Iron Store, under Mt. King William, before swinging to the west over Mt. Arrowsmith. The proposed West Coast-road, instead of diverging to the south, follows Scott's, Counsel's, and Paton's tracks, round the bottom of the lake, up the Cuvier Valley, and passes over the divide by Gould's Sugarloaf. Another old track follows the course of the Traveller River, and reaches the head of the lake by way of the Traveller Plateau.

The present road is fairly well formed, but needs attention from Bronte onwards. The expenditure of a few hundred pounds would make the track quite suitable for motor traffic to the lake, whose wondrous beauty warrants such an expenditure. The hut at Cynthia Bay is in a very unfinished condition, and needs to be enlarged. The boat is in very fair order, but the strong westerly winds, that seem to blow almost continuously down the lake, make boating without an auxiliary engine somewhat arduous.

(c) PREVIOUS LITERATURE AND ACKNOWLEDGMENTS.

1. Col. W. V. Legge, R.A., F.G.S. (Proc. Roy. Soc., 1887), wrote a chatty account of the district, and of its beauties and wonders.

2. Graham Officer, B.Sc. (Proc. Roy. Soc., 1893), gives a general description of the Geology of the district. In it he states that he did not find any traces of early Palæozoic sediments in the Cuvier Valley or basalt at the mouth of the Derwent, as reported by R. M. Johnston, F.L.S. (Proc. Roy. Soc., 1893). He also devoted considerable space to giving his reasons for believing that there are no traces of glacial action in the district. His main argument is based on the non-appearance of glacial pavements or ice-scratched boulders, neglecting the appearance of the valleys, the moraines, and erratics so evident on every side. I can only account for this by supposing that the traces were hidden in scrub.

He does not attempt to suggest any theory for the formation of the lake, except a vague reference to earth-movements. He definitely states his opinion that the numerous lakes on the Traveller Plateau are due to sub-aerial erosion on an originally unequal surface.

3. R. M. Johnston (Proc. Roy. Soc., 1893) makes numerous references to traces of glaciation in the neighbourhood, including the Lakes Dixon and Undine, and the valley in which they lie, and the Cuvier Valley, but bases his theory of the formation of Lake St. Clair on a mythical flow of basalt damming the source of the Derwent.

4. Geoffrey Smith, M.A. ("A Naturalist in Tasmania," 1909), describes a short visit to Lake St. Clair, and his attempts at dredging in the lake, which he found very destitute of life.

I wish to acknowledge the help I received from my own and Mr. Lord's party, including Mr. Reynolds, who supplied me with notes on Mt. Rufus and Mt. Hugel, and the track to the south, Mr. F. B. Cane, whose magnificent photographs are so well known, and Mr. G. L. Propsting, who gave valuable assistance in map-making. I am also indebted to Messrs. A. N. Lewis, A. M. Reid, and A. McKay, for help and kindly criticism.

2. PHYSIOGRAPHICAL GEOLOGY.

(a) PRESENT TOPOGRAPHY.

The eastern boundary of the area in question is formed by the Traveller Plateau, which stretches away, without much alteration in altitude, to the Great Lake. The average altitude is from 3,000 to 3,500ft. above sea level. The surface, as viewed from Olympus, is covered with roche-moutonnées and small lakes and tarns, among which rise the Travellers' Rest, Nive, and Mersey Rivers. The rock faces are smoothed and rounded, and there appears to be little vegetation. The edge is steep and columnar in structure, overhanging the lake, and sweeps northward on its extreme western face, and is divided from the Pelion and Cradle Districts by the Forth and Mersey Gorges. Lying under the Travellers' about half-way along the lake, is Mt. Ida, a conically shaped mountain, crowned by diabase columns, and overshadowing Lake Laura. At the north of the lake, extending far back to the three-fold multiple cirques of the Du Cane Range, is a wide button-grass plain, down which flow the Narcissus and other rivers. To the south

of the plain are a row of peaks, Manfred, Cuvier, and Byron, leading to mighty Olympus (4,680ft.), which towers over the south-western borders of the lake. Its base is covered by a magnificent beech forest, with leatherwood, waratah, celery-top, King Billy, tallow-wood, and other West Coast flora. Above rise cliffs of columnar diabase, 300ft. high. Behind Olympus is the Vale of Cuvier, 10 miles long, a button-grass plain crossed by moraines, and gradually rising from Cynthia Bay to beyond Lake Petrarch (about 500ft. above the lake). Down the Vale of Cuvier from Petrarch runs the Cuvier River. To the west of Petrarch is a circle of peaks, Byron, Coal Hill, and Gould's Sugarloaf, sweeping round till it meets Mts. Hugel and Rufus with the Hugel Creek Valley between them. Between Rufus and Mt. Gell, on the south-western boundary of the Scenic Reserve, is the upper valley of the Franklin River, with Lakes Undine and Dixon. The southern portion of Lake St. Clair widens out with Cynthia Bay on the west, and the mouth of the Derwent, and with the Derwent Lagoons on the east. Stretching to the south towards the King William Ranges are wide button-grass plains lying between Mts. Charles and Rufus, with the Bedlam Walls rising between. Another valley stretches under the southern edge of the Traveller Plateau towards the Clarence River, across which plateau flows the Travellers' Rest River, which joins the Derwent a little to the south of the Derwent Bridge.

(b) Development of Present Topography.

The present topography has been developed by fluviatile and glacial erosion subsequent to the intrusion of the Cretaceous, or at any rate Post-Jurassic, diabase. The outstanding features of the present topography are what may, for the present, be denoted as the intermediate and lower plateaux with residual mountains representing a former higher plateau. The intermediate plateau, the Traveller, is undoubtedly the western end of the Central Plateau. This has a comparatively level surface, with such immature drainage that the Nive and Mersey headwaters are so intermingled that instances of bifurcation are probably present. The rivers have not yet cut any deep gorges in its surface, probably on account of its massive structure, only the overlying sediments having been removed. It may possibly have been protected from erosion by an ice-cap during the periods of glaciation. The Traveller River has cut into it at one corner, perhaps where the sill structure begins, as has happen-

ed at Mt. Ida, where another small gorge has penetrated a short distance. The gorges of the Forth and Mersey, probably working along a fault plane, have separated it from the Pelion and Cradle districts to the north, scalloping it out into prominences.

The lower plateau, nearly 1,000ft. lower, includes the valley of the lake and the button-grass plains, and stretches away past Lake Echo. Here the erosive action is more apparent. The valley of the lake and the Derwent seems to have resulted from combined river and glacial action along a great fault-plane, an action which has been assisted by the comparatively small depth of the upper sill, covering soft sedimentary rocks. Once the upper crust, at high altitudes, had been pierced, the gorges developed rapidly, and now only residual mountains remain. The same may apply to the Cuvier Valley. This will be discussed in more detail in later sections of this paper. The wide valleys are due to the action of glaciers working along the previously eroded river beds, and the lakes have been formed behind the morainal dams. The lakes on the Traveller Plateau are probably due to the glacial "scooping" assisted by later nivation rather than to inequalities of the surface.

3. STRATIGRAPHICAL GEOLOGY.

(a) Pre-Cambrian.

These rocks, except as isolated pebbles in the Permo-Carboniferous glacial drifts, do not appear in the district under review, but approach close to it on the south, west, and north-west. They have been reported (Johnston) in the valley of the Franklin at Lake Dixon, behind Mt. Rufus, in the valleys of the Alma and Inkerman Rivers to the south of Gould's Sugarloaf, at Mt. Gell, the southern boundary of the Reserve, and to the west of the Du Cane Range. Mr. Gould states that they probably underlie Lake St. Clair, and its surroundings. R. M. Johnston (Proc. Roy. Soc., 1893) reports their occurrence on Mt. Hugel, Gould's Sugarloaf, and the Du Cane Range. I was not able to verify this, owing to lack of time. Graham Officer (Proc. Roy. Soc., 1893) states that he could not find any traces on Hugel.

(b) Early Palæozoic.

These rocks do not occur in the immediate vicinity, but are to be found on the Eldon and Loddon Ranges, and other localities to the west and south.

(c) Permo-Carboniferous and Trias-Jura.

These rocks dominate the whole district. Traces of the Permo-Carboniferous glaciation are to be found in the boulders of coarse conglomerate among the morainal material of the Cuvier Valley, and south of Cynthia Bay. These contain pebbles of quartzite, granite, and porphyroids of the earlier formations. Coarse pebbly sandstone beds were found near the water's edge at the Beech Forest, and possibly may occur in the Cuvier Valley below Mt. Hugel. The upper beds were represented by finer-grained felspathic sandstones standing out as cliffs high up on the slopes of Olympus, Ida, Hugel, and Rufus, and particularly noticeable on Coal Hill, where coal, probably one of the seams of the Upper (Jurassic) Measures, but perhaps of the same horizon as the Pelion coal, is found among the sandstones. Merging into these upper sandstones are fine-grained white to brown sandstones of Ross series, and shales highly coloured by the ferruginous content of the overlying diabase, and containing obscure plant remains (*Phœnicopteris?*).

The Upper Permo-Carboniferous sandstones and the Lower Trias-Jura are so alike in lithological characters, that it is hard to determine, without more evidence, where the dividing line may be taken. The lower slopes of the mountains are so covered by talus from the overlying diabase caps that it is difficult to see what the underlying rock is, and to build up a true stratigraphical series. No traces could be found of any Permo-Carboniferous limestones. A proper study of Coal Hill would probably give profitable results.

(d) Diabase Intrusions.

The diabase in this district appears to be in the nature of sills or intrusive sheets overlying the sandstones and shales mentioned in the previous section. This bears out the statement made in chapter IV. of Mineral Resources Paper No. 7, on the Coal Resources of Tasmania, which reads as follows:—"Only a few forms of typical laccolithic structure "have been located, but the greater portion of the diabase "of Tasmania, namely, that constituting the Central Plateau, "can be best described as an asymmetric transgressive igneous "mass of a general laccolithic type. The eastern and main "portion of this, to the greatest depth observed, shows no "sign of definite bottom, but its western extension shades "off gradually into a typical sill structure, the sills of Barn "Bluff, Pelion, and Eldon Range being portions of this "Central Plateau mass. It has been clearly demonstrated

"that the mass rose upwards under the Plateau, lifting the "Permo-Carboniferous and Trias-Jura sediments bodily with "it. Concurrently the invading igneous mass discovered a "plane of weakness in the bedding-planes of the sediments "on the western edge, and travelled along it to form the "typical intrusive sheet. The overlying sediments present "during this intrusion have since been almost completely re-"moved by denudation."

This statement is borne out by the occurrences of the diabase as found in this district. At Mt. Ida, the Traveller Plateau is seen resting on the sandstones, and the columnar structure along the boundaries points to it being the edge of a sill ending at the lake. Except where a very steep face occurs, both here and on the sides of the mountains, the underlying strata cannot be seen on account of the masses of talus from the overlying sills which cover the hillsides. Farther eastward from the lake it is more massive in structure, and is part of the original diabase mass. Bedlam Walls and Mt. Charles appear to be subsidiary peaks, emanating from the mass of the Central Plateau. The diabase of the Bedlam Walls is different in texture from that found on Mt. Olympus, conforming more to the diabase of the Central Plateau. This would point to a different origin.

At the Derwent Bridge, close to Bedlam Walls, occurs a deposit of sandstone of Trias-Jura facies, through which the Derwent has cut a channel, and on which the bridge is resting. It is apparently part of the upper surface of the lower plateau which has escaped erosion on account of its position. There are no contour maps available to determine the extent of this plateau, or data yet to hand to account for its formation, but it appears to extend east of the Derwent Valley past Lake Echo, and has determined the base line of erosion for the plain stretching south from Lake St. Clair.

The appearance of the diabase as caps on the tops of the mountains to the west of the Derwent Valley, and in the Pelion and St. Clair districts, in the same line, and throughout at a much higher elevation (about 1,000ft.), has led me to the conclusion that it is the remnant of an immense plateau or sill extending from Cradle Mountain southwards, approximately along the line of the Cambro-Ordovician sediments. There is no evidence to show that this plateau was connected in any way with the Central Plateau, nor is it probable that each is a separate entity with its own feeding dyke. In fact, in several places, as at Coal Hill and Mt. Pelion East, the diabase has been entirely removed, and no

traces of feeding dykes are apparent. The strata beneath have not been disturbed or altered in any way, as would have been the case if such had occurred. Apparently the feeding dykes for this plateau have yet to be found. Lake St. Clair and the Valley of the Derwent have been eroded out along the junction of the two plateaux. Dr. Griffith Taylor ("Australian Environment") suggests that the Derwent flows in a Rift Valley, but gives no evidence for such an assumption. It appears more probable that the valley has been formed by erosion along a fault line.

The structure of the diabase varies considerably with the localities in which it is found. The normal diabase of the district is more finely grained than that usually met with in the vicinity of Hobart. This may be due to the comparatively shallow depth of the sills, with the consequent more speedy cooling. At the foot of the sill on Olympus, it is extremely fine grained and platey in structure. Above, it is formed of massive columns, which, where undermined, gradually lean over at greater and greater angles until they topple over, and pile up in a tangled mass of boulders below. The summit of the mountain is almost level, with a curious crevice, about fifty yards long, and closed at both ends, descending into the heart of the mountain. The sides are columnar, but the depth I could not determine, as it was filled with snow. It was probably caused by the subsidence of the underlying sediments. Near by, the diabase was of an entirely different structure, being almost a gabbro, and highly porphyritic, with large crystals, resembling hornblende in the hand specimens. The general structure of the rock showed that the mountain had been considerably higher and larger, the overlying rocks having been removed by erosion.

(e) Post-Diabase Sediments and Basalt.

These sediments consist almost entirely of glacial till, boulder-clay, and drift covering the glaciated piedmont. There are also a few examples of the deposition of river gravels and alluvium.

Among the boulders embedded in the moraine were found curious rounded blocks of mudstone of unknown age, of all sizes from that of a football to that of an egg. When exposed to the weather, expansion cracks appeared, and the rock was then easily broken with conchoidal fracture. It was difficult to determine how they were formed or where they came from. They certainly were not formed from the boulder clay.

Along the beaches were scattered large deposits of brightly coloured pebbles from the disintegrated conglomerates. Here, also, appeared quartz grains bound together by an iron matrix, probably due to organic action on the button-grass plains. The same action may be observed at Macquarie Plains, in the valley of the Styx, whose waters are highly coloured from the matter derived from the plains on which it rises.

No basalt was found nearer than Bronte, whose plain is covered and rendered fertile by the decomposed remains of a vast laval flow, through which the Nive has cut its deep channel.

R. M. Johnston (Proc. Roy. Soc., 1893) makes the following statement when discussing the formation of lakes in general: "2. By ponding back of streams by lava. Type, "Lake Ardat in Auvergne, and probably Lake St. Clair in "Tasmania." I cannot account for this statement, as no evidence of the occurrence of basalt was found in the vicinity.

4. GLACIAL GEOLOGY.

The Pleistocene glaciation was superimposed on an area already subjected to long ages of severe erosion, materially assisted by the high elevation and heavy precipitation. The river valleys, cut out along the lines of faults, were already formed. Without evidence of the inter-glacial periods, it is almost impossible to state definitely that Tasmania experienced four ice-ages in the Pleistocene as occurred in the Northern Hemisphere. All that can be done with the data at present to hand is to examine the work done by the glaciers, arrange it as nearly as possible in chronological order, and divide that up into sections according to the class of work and locality of operations. Each section may then be referred to in terms of the four northern ice-ages, and will be found to approximate very closely to them.

Taking this as a working basis, I shall endeavour, somewhat clumsily, to determine the order of sequence of the work of glaciation in this district. The great factor to be taken into consideration is that we have a hgher and one or more somewhat lower plateaux along the margins of which the rivers had already begun to carve their valleys. The higher plateau, owing to the elevation, thinness of sill, and softness of the underlying rock, had already become much dissected. The snow collected in deep masses on these plateaux. The intermediate plateau was protected from much erosion by an ice-cap which covered the whole sur-

face, as evidenced by the lack of morainal matter. The work done here was in the form of disintegration of the rock beneath the ice, and its removal as fine detritus by water action. The general level surface would preclude any great movement unless due to the weight of ice pressing outwards. Most of the erosive work would be done on the higher plateau, where the streams had already carved valleys, down which the glaciers would flow, and soon huge broad valleys would be formed separating out the peaks which now appear, and completing the dissection of the plateau. Mr. Lewis, in his paper on the Mt. Anne district (1923), stated his opinion that either the Gunz glacial period did not occur, or that the Mindel had obliterated all traces of its action. I am of the opinion that the Gunz glacial period did occur, and that the preliminary work of dissecting this plateau and widening the great valleys could be referred to it, despite the absence of morainal material.

To the Mindel ice-age may be referred the more striking glacial phenomena observable at the present time, obliterating all traces of the Gunz glaciation. A huge glacier flowed across the site of Lake St. Clair from the Du Cane Range, below the summits of the mountains, as evidenced by the enormous amount of morainal material. It may possibly have been loaded by ice which fell over the cliffs from the Traveller Plateau. Receiving tributaries on the way it pushed southward past the King William Ranges, though evidences of morainal matter become slighter as you pass these mountains (Reynolds). The course taken would be between the Bedlam Walls and Mt. Rufus, the position of the moraines being easily seen, as they are covered with Eucalypts and light scrub, while the intervening out-wash has button-grass. The site of the lake may be an over-deepened valley, but still the depth of the terminal moraine must be 400 to 500ft. The morainal material was piled up against Bedlam Walls. The two main tributary glaciers near the lake, the Cuvier-Hugel and the Travellers' Rest, were modified by the larger glacier.

The Cuvier-Hugel glacier was much the larger, and was composed of two glaciers, one flowing from Gould's Sugarloaf, Coal Hill, and Byron, along beneath Olympus, and the other from between Hugel and Rufus. The valley of the former is now occupied by the Cuvier River coming from Lake Petrarch, and that of the latter by the Hugel Creek. Meeting the ice of the larger glacier, which was at

a lower level, an immense moraine was built up, and a pressure ridge formed between the two glaciers. An appreciable quantity of the material was also spread along the lower slopes of Rufus, and helped to heighten the western portion of the terminal moraine of the St. Clair glacier, the general slope of which is from west to east. Retreating up the valley, it left behind row after row of moraines with steep downside faces, covered with Eucalypt scrub, and the intervening spaces again covered with button-grass. The last moraine near Lake Petrarch is particularly large with a wide outwash plain, through which a creek has wound its way, but into which it has not cut deeply. The Cuvier and Hugel Valleys may be termed "hanging valleys."

Mr. Reynolds has kindly furnished me with notes on the Hugel Creek Valley. "From the high ground above the pre-"sent valley, down which the Hugel Creek flows, a glacier "has worked its way, cutting out a cirque, the top of which "is the ridge running from Mt. Hugel to Mt. Rufus, and "thence it has flowed down the valley, either joining the "Cuvier Valley glacier or flowing independently into what is "now the lower part of the lake. At least four moraines "have been left in the valley, forming three small lakes. From "probably the same source another glacier has flowed in a "northerly direction, presumably towards Lake Petrarch. It "has cut the other side of the Rufus-Hugel cirque, making it "a miniature example of the K. Col of National Park (Mt. "Field)."

The valley containing Lakes Undine and Dixon shows great evidences of glaciation. Mr. R. M. Johnston (Proc. Roy. Soc., 1893) describes the valley of Lake Dixon as "par "excellence, the ideal of a perfect glacial valley." It is extraordinary how he missed the signs so evident at Lake St. Clair.

The Travellers' Rest Valley contained two glaciers, one flowing from the region of the Clarence, and the other from the Traveller Plateau. These built a ridge at the eastern end of the lake, the most work being on the northern side of the valley. The glacier from the Clarence moved sluggishly down an almost level valley, base-lined by the St. Clair Glacier, and so did not cut down so deeply, as evidenced by the sandstone at the Derwent Bridge. It made its way down between Mt. Charles and Bedlam Walls.

The next glacial period (the Riss) was characterised by less intensive action, being confined to cirque action at the head of the valleys. This almost invariably took place on the eastern side of the ridges. The cutting back of the cirques, separated by cols, led to the formation of "horns" like Mt. Byron and Mt. Ida. To this time may be ascribed the formation of Lake Laura, fifty feet above the present level of Lake St. Clair, the Traveller Lake, the lakes beyond Lake Petrarch, the three-fold multiple cirque of the Du Cane Range, with the wide plain of the Narcissus and other rivers, and many other features, including the traces of ice action on the east of Bedlam Walls. At some time a large snow bank has lain between Olympus and the moraine which banks back Lake Petrarch, gradually removing the moraine by nivation, and forming a large outwash apron below.

The last period, the Würm, affected only the highest areas. The most noticeable feature attributable to this period are the small tarns under the summit of Olympus. They lie in a cirque overlooking the lake which has almost cut the top of the mountain into two equal areas. The upper tarn is perfectly circular, lying in a semi-circle of cliffs. The other tarn is almost rectangular, and appears deeper. Separating the two is a high, sharply defined pressure ridge running down from the mountain summit. It is probable that the divide at the south end of the great cliffs has been formed in some such way.

5. ECONOMIC POSSIBILITIES.

With the exception of the generation of electricity by water power, this district has few economic possibilities.

The proposed Hydro-Electric dam in the vicinity of Mt. Hobhouse would largely alter the district from a tourist point of view, and would hinder communication, not only with Lake St. Clair, but with the West.

There may be some prospect of coal in the vicinity of Coal Hill.

6. APPENDICES.

(a) Description of Plates

Plate XI.—Sketch Map of Vicinity of Lake St. Clair.

Plate XII., Fig. 1.—On Mount Olympus.

Fig. 2.—Arriving at Lake St. Clair, Christmas, 1923.

Plate XIII., Fig. 1.—Lake St. Clair.
Fig. 2.—Cuvier Valley and Mount Rufus.

Plate XIV., Fig. 1.—Lake St. Clair, Lake Laura, and Mount Ida, from Mount Olympus.
Fig. 2.—The Du Cane Range from Mount Olympus.

Plate XV., Fig. 1.—Mount Olympus from the Cuvier Valley.
Fig. 2.—Looking West from Mount Rufus.

Plate XVI., Fig. 1.—The Cuvier Valley from Mount Olympus.
Fig. 2.—Lake Petrarch from Mount Olympus.

Plate XVII., Fig. 1.—Mount Byron and Mount Olympus.
Fig. 2.—Lake Petrarch.

Plate XVIII., Fig. 1.—Cynthia Bay, Lake St. Clair.
Fig. 2.—View from Cynthia Bay, Mt. Olympus in distance.

Plate XIX., Fig. 1.—Mount Ida and Lake St. Clair from Eastern Slopes of Mount Olympus.
Fig. 2.—The Hut at Lake St. Clair.

(b) List of Works Referred To

Officer, Graham, B.Sc. "Geology of Lake St. Clair District," P. & P. Roy. Soc., 1893.

Johnston, R. M., F.L.S. "Glacier Epoch of Australasia," P. & P. Roy. Soc., 1893.

Johnston, R. M., F.L.S. "Notes on Geology of Lake St. Clair," P. & P. Roy. Soc., 1893.

Legge, Col. W. V., R.A., F.G.S. "Highlands of Lake St. Clair," P. & P. Roy. Soc., 1887.

Lewis, A. N., M.C., LL.B. "Mt. Anne and Weld River Valley," P. & P. Roy. Soc., 1923.

Lewis, A.N., M.C., LL.B. "Glacial Remains, National Park," P. & P. Roy. Soc., 1921.

Geological Survey. "Underground Water Supply Paper," Nos. 1 and 2.

Geological Survey. "Coal Resources of Tasmania," Mineral Resources, No. 7.

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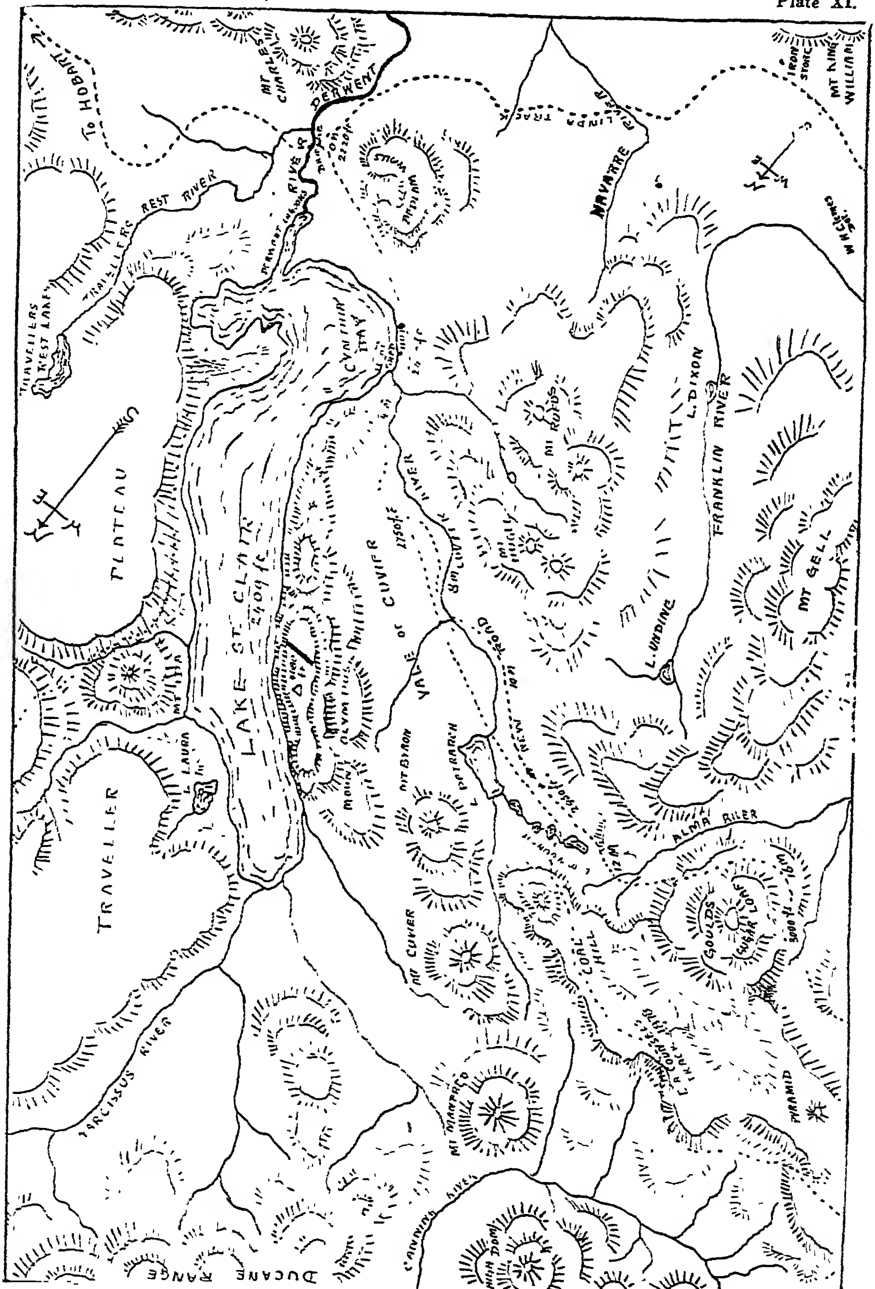
Smith, Geoffrey. "A Naturalist in Tasmania."

Hobbs. "Characteristics of Existing Glaciers."



Sketch Map of Vicinity of Lake St. Clair.

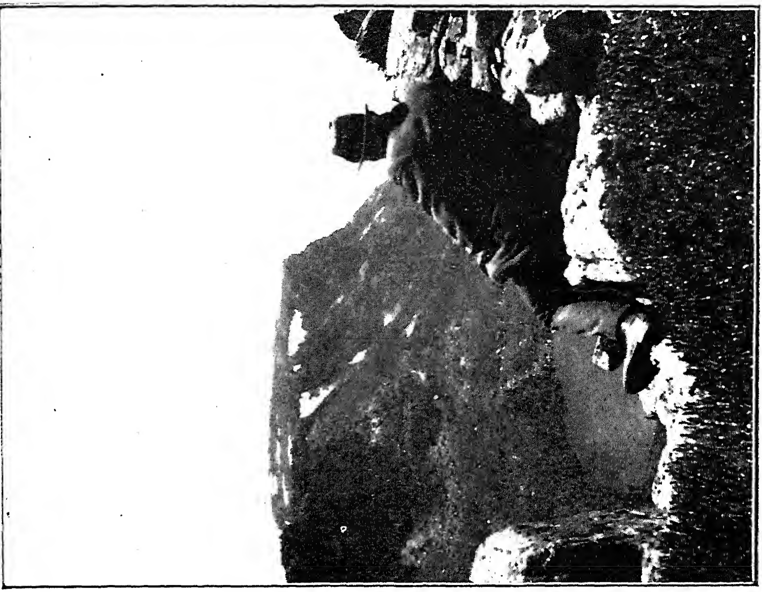


Fig. 1. On Mt. Olympus. Clive Lord, photo.

Fig. 2. Arriving at Lake St. Clair, Christmas, 1923. Clive Lord, photo.

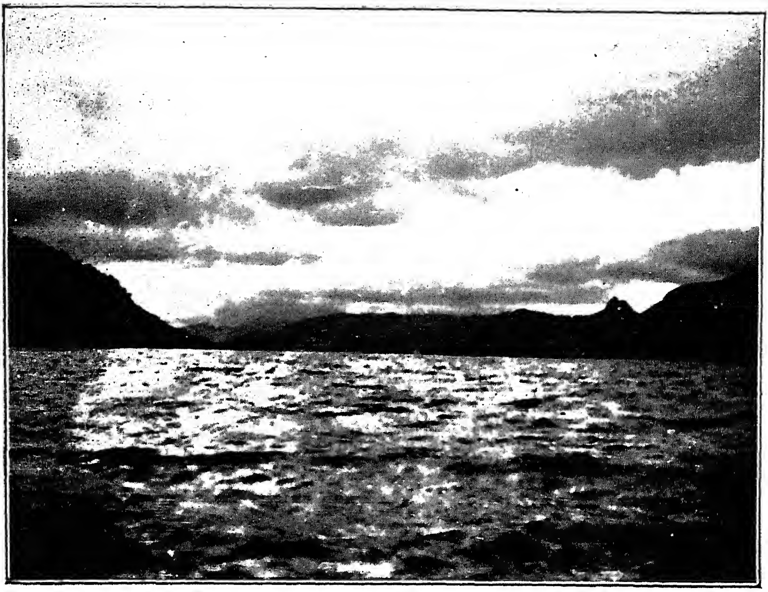


Fig. 1. Lake St. Clair.

Clive Lord, photo.

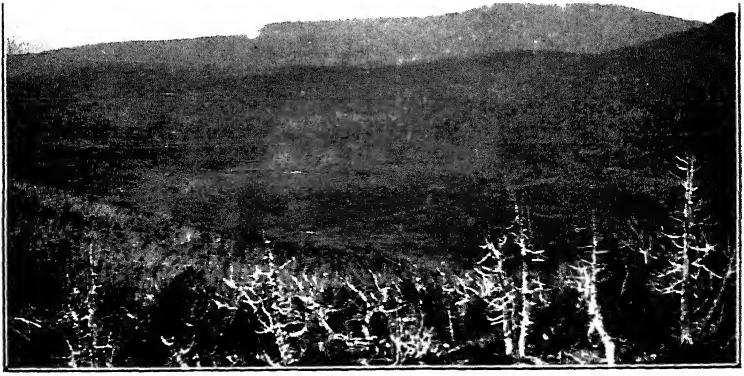


Fig. 2. Cuvier Valley and Mt. Rufus.

Clive Lord, photo.

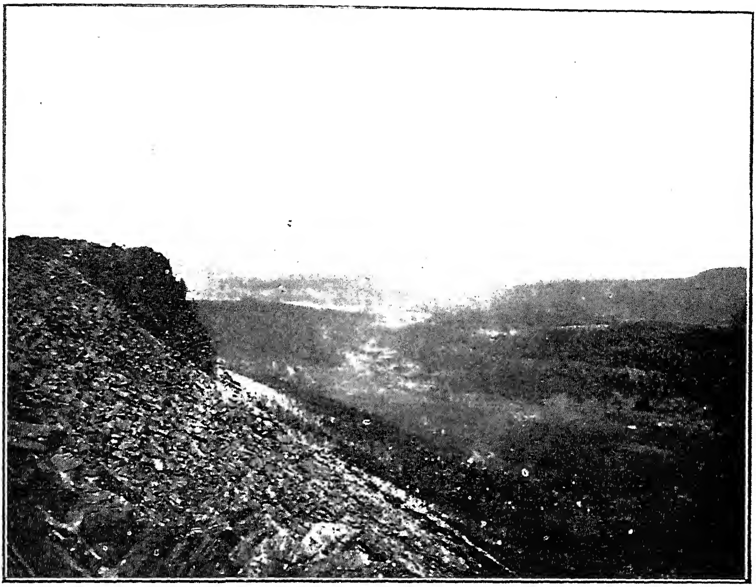


Fig. 1. The Cuvier Valley, from Mt. Olympus.
Clive Lord, photo.

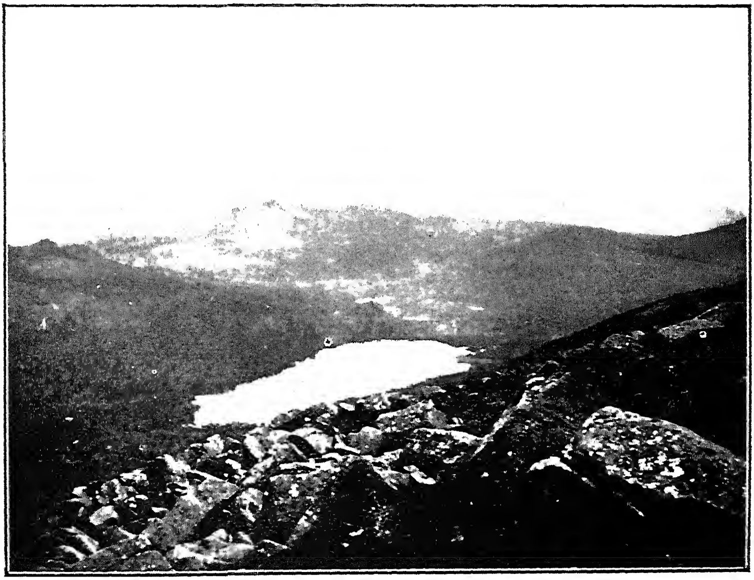


Fig. 2. Lake Petrarch from Mt. Olympus.
Clive Lord, photo.

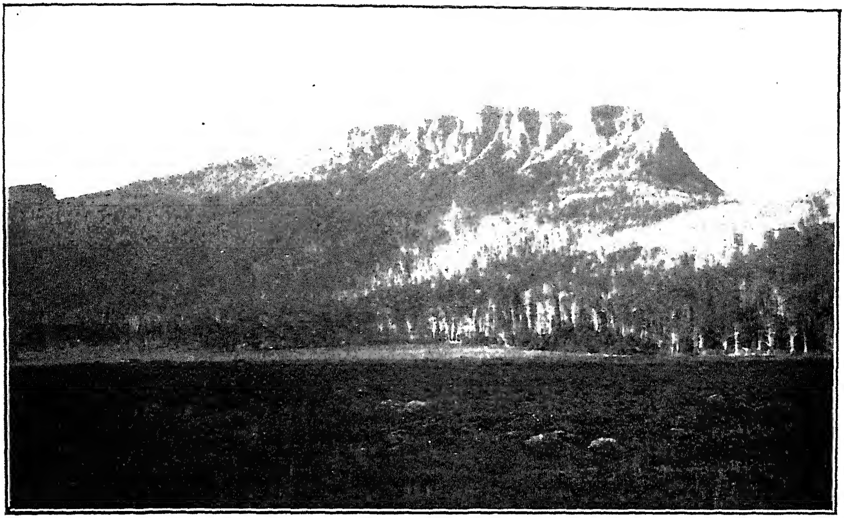


Fig. 1. Mt. Olympus from the Cuvier Valley.
R. C. Harvey, photo.

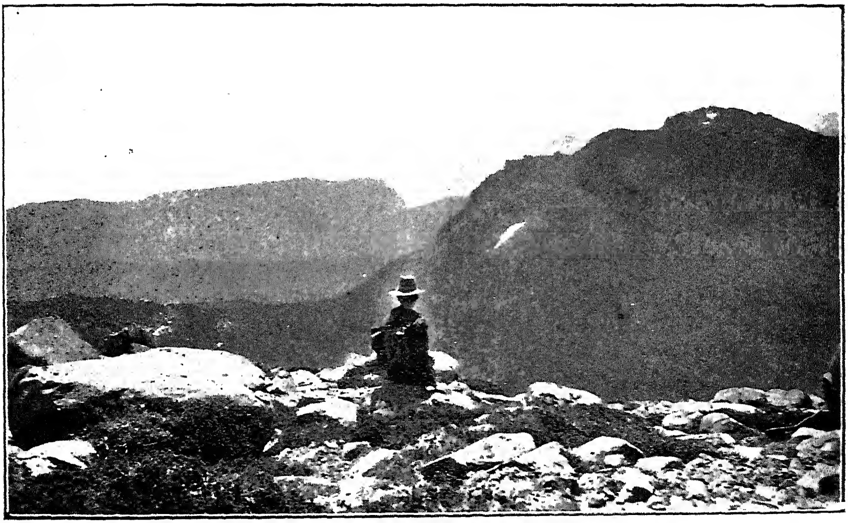


Fig. 2. Looking West from Mt. Rufus.
R. C. Harvey, photo.

Fig. 1. Lake St. Clair, Lake Laura, and Mt. Ida, from Mt. Olympus.
F. B. Cane, photo.

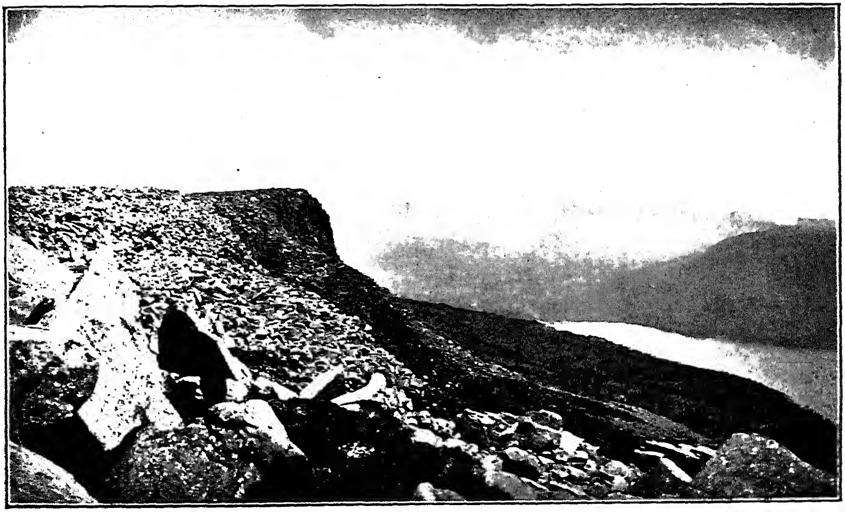


Fig. 2. The Du Cane Range from Mt. Olympus.
F. B. Cane, photo.

Fig. 1. Mt. Byron and Mt. Olympus.

F. B. Cane, photo.

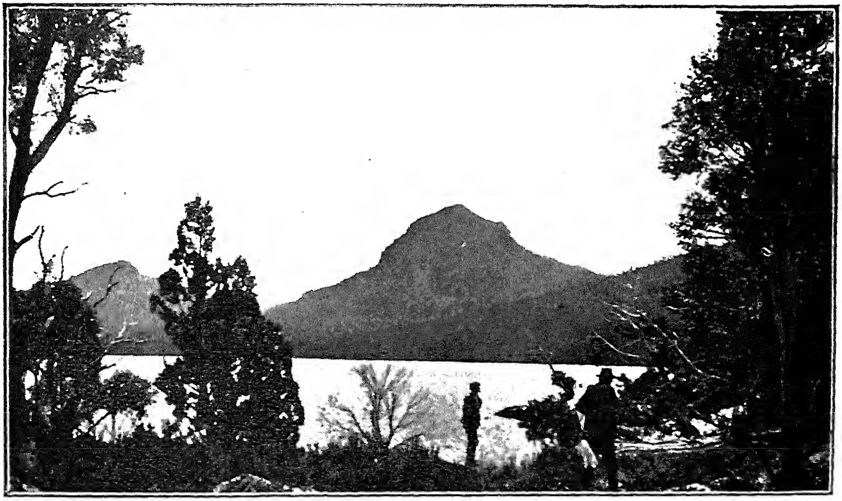


Fig. 2. Lake Petrarch.

F. B. Cane, photo.

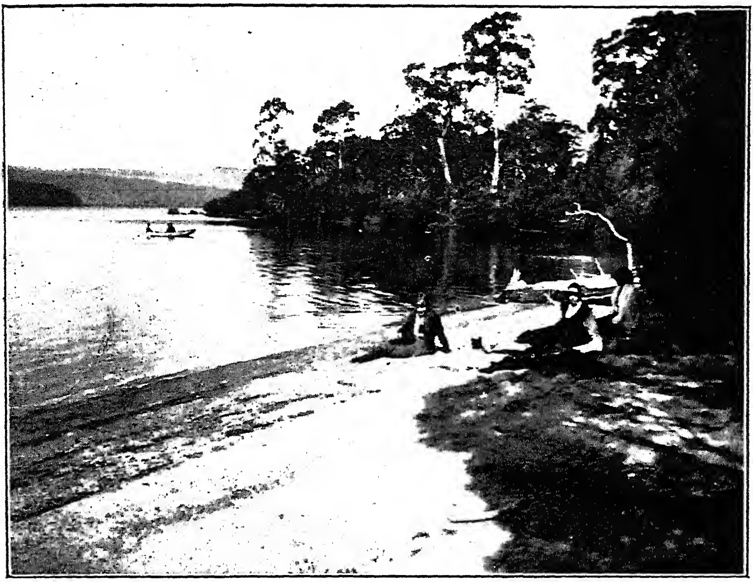


Fig. 1. Cynthia Bay, Lake St. Clair.
Clive Lord, photo.

Fig. 2. View from Cynthia Bay, Mt. Olympus in distance.
Clive Lord, photo.

Fig. 1. Mt. Ida and Lake St. Clair from Eastern Slopes of Mt. Olympus.
R. C. Harvey, photo.

Fig. 2. The Hut at Lake St. Clair, Christmas, 1923.
R. C. Harvey, photo.

NOTES ON SOME TASMANIAN MESOZOIC PLANTS.

Part I.

By A. B. Walkom, D.Sc.,
Secretary, Linnean Society of New South Wales.

(With 18 Figures.)

(Read 10th November, 1924.)

Through the kindness of Messrs. Clive Lord and P. B. Nye I have been enabled to examine collections of Mesozoic Fossil Plants from the Tasmanian and Launceston Museums and the Geological Survey of Tasmania. This has given me the opportunity of checking the determinations of some of these fossils made by the late R. M. Johnston some thirty to forty years ago. Unfortunately, a large proportion of the specimens had lost their locality labels, but it is probable that one acquainted with the rocks in which these fossils occur in Tasmania could, with reasonable certainty, determine the localities from which the majority of the specimens came.

The notes in this paper are not quite complete, but as many of the specimens were from the exhibition collections of the Tasmanian Museum, it was desirable that I should not keep them very long. In order not to delay publication of the results of my examination I have thought it advisable to present the following notes now, and hope, during next year, to be able to supplement this paper with another short one, which should contain a few additional observations, together with some analysis of the Tasmanian Mesozoic floras, and comparison with the Mesozoic floras of the mainland and other areas.

At this stage I would like to take the opportunity of paying a tribute to the work of the late R. M. Johnston on the fossil plants of Tasmania. It is not always easy at the present day to appreciate the difficulties under which work of this kind was done thirty years or more ago. Although many alterations in the names used by Johnston are suggested below, it should be pointed out that a very great amount of work has been done on Fossil Plants during the past twenty years, and that, in many cases, the suggested changes are only necessary to bring Johnston's work into line with our present improved knowledge of the whole subject.

I have to express my gratitude to both Mr. Lord and Mr. Nye for the opportunity given me of studying the collections, and to express the hope that the results may be a contribution to the study of the Tasmanian fossil flora, which will, in some measure, repay them for the trouble they have taken.

The figures are natural size, except where it is stated otherwise.

Neocalamites Carrerei, Zeiller.

Among specimens from the Launceston Museum there are some examples of Equisetaceous stems with numerous long narrow leaves at the nodes. These may belong to *Neocalamites Carrerei*, a species not uncommon in rocks of Lower Mesozoic Age in Eastern Australia, and already figured from Queensland (Walkom, 1915, Pl. 1). Specimen B 875 may also belong to this species.

Phyllotheca australis, Brongn.

The late R. M. Johnston (1885, p. 365; 1888, Pl. 22) recorded the three species, *Phyllotheca australis*, *P. ramosa*, McCoy, and *P. Hookeri*, McCoy, from the Mesozoic Coal Measures at a number of localities. There does not appear to be anything in the descriptions of these three species by which they can be separated from one another, and it is probable that only a single species is represented—a conclusion already suggested by some authors.

In the figure of *P. Hookeri* (Johnston, 1888, Pl. 22, f. 16) shewing the leaf-sheaths, it appears as if the full length of the leaves may not be shown, and the general appearance of the figure suggests that the specimen may be a *Neocalamites*.

Cladophlebis australis (Morris).

Alethopteris australis, Johnston, Pap. Proc. Roy. Soc. Tas 1885 (1886), 374.

? *Neuropteris antipoda*, Johnston, *ibid.*, 1886 (1887), 172, Pl. 3, f. 4.

Alethopteris serratifolia, Johnston, *ibid.*, 1886 (1887). 172, Pl. 2, f. 1.

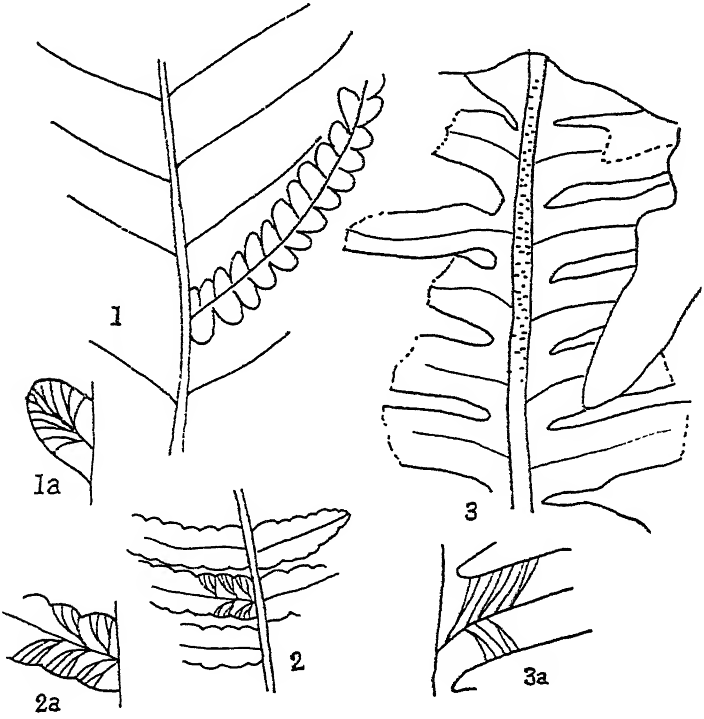
This very common species seems to be present in almost every collection of Lower Mesozoic plants in Australia. The Tasmanian examples, as a whole, have rather small pinnules with margins usually entire, but occasionally denticulate.

The specimen figured by Johnston as *Neuropteris antipoda* is probably an imperfectly preserved example of this species.

Alethopteris serratifolia was regarded by Johnston as distinct from *A. australis* by "its more robust appearance "and its crisp or sinuous dentate pinnulæ," but I am unable to distinguish it from the common species, which shows considerable variation.

Cladophlebis tasmanica (Johnston). (Fig. 1.)

Sphenopteris tasmanica, Johnston, Pap. Proc. Roy. Soc. Tas., 1895 (1896), 60, f. 10-13.



Figs. 1, 1a.—*Cladophlebis tasmanica* (Johnston). 1a, single pinnule enlarged (X 3).

Figs. 2, 2a.—*Cladophlebis Johnstoni*, n.sp. 2a, part of single pinnule enlarged (X 2).

Figs. 3, 3a.—? *Phlebopteris alethopteroides*, Eth. Jr. 3a, part enlarged showing venation (X 1.6.).

Frond bipinnate. Pinnæ opposite, or almost so, close, linear. Pinnules small, ovate, attached by whole base, margins entire; each pinnule is traversed by a single median vein with a few secondary veins, branching once or twice, and at an acute angle to the mid-vein.

This species, placed by Johnston in *Sphenopteris*, differs widely from that genus in the form of the pinnules, their mode of attachment and venation, and appears to agree better with *Cladophlebis*. The pinnæ are up to 8 mm. wide, and 5 cm. long.

Specimen B 1029, in which the venation does not show, may possibly belong to this species.

Cladophlebis Johnstoni, n.sp. (Fig. 2.)

Frond bipinnate, large. Pinnules subfalcate, opposite or alternate, attached by whole base; margins lobed to a varying extent—in the upper part of the pinnæ some of the pinnules have an almost entire margin. Venation alethopteroid. Pinnules in general 1.5-2 cm. long by 5 mm. broad, with a prominent midrib and secondary veins which branch once, twice, or occasionally thrice.

This is a species quite distinct from any that I have met in the Australian Mesozoic floras. The specimens are all of sterile fronds, and in general appearance are not unlike such species as *Coniopteris arguta* (L. & H.) figured by Seward (1900, Pl. 17, f. 4, 5) from the Jurassic of England.

Locality.—Three miles north of Bagdad.

? *Phlebopteris alethopteroides*, Eth. Jr. (Fig. 3.)

A single specimen, showing part of a broad pinna, with elongate strap-shaped pinnules, having a prominent midrib and simple or branching secondary veins at a moderately wide angle to the midrib, and about .5 mm. apart, approaches most closely to the above species. The species has been recorded and figured from the Walloon Series (Jurassic) in Queensland (see Walkom, 1917, p. 8).

THINNFELDIA.

The Tasmanian specimens conform remarkably well to the limits for the species already suggested in the case of collections from Queensland and New South Wales (Walkom, 1917, p. 12; 1921, p. 8). While it is admitted that the separation of the species is, to some extent, artificial, and that all are possibly examples of one very variable species, it has the advantage that the species described are very easily de-

terminable. I might repeat here that all have a dichotomous rachis; the only bipinnate form (*T. Feistmantelli*) has rounded ovate pinnules without a midrib; of the simple dichotomous fronds, *odontopteroides* has rounded or ovate pinnules without a midrib, and *lancifolia* has elongate pinnules with a distinct midrib. For further discussion reference may be made to the papers quoted above.

Thinnfeldia Feistmantelli, Johnston. (Fig. 4.)

Thinnfeldia obtusifolia (pars), Johnston, Geol. Tas., 1888, Pl. 25, f. 3, 9 (*not* figs. 7, 14.)

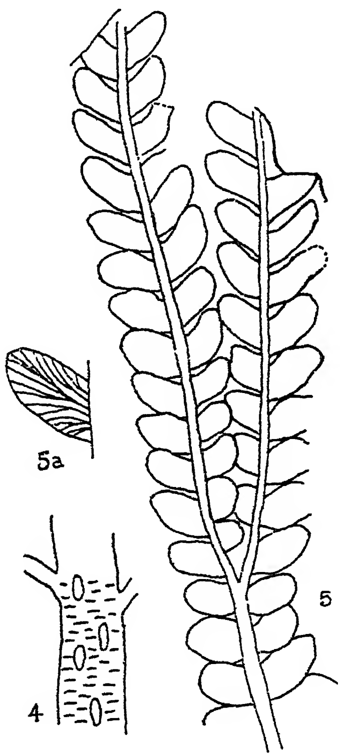


Fig. 4.—Part of rachis of *Thinnfeldia Feistmantelli* showing usual transverse scars, and 4 vertically elongated scars (X 1.3).

Figs. 5, 5a.—*Thinnfeldia odontopteroides* (Morris). 5a, single pinnule enlarged (X 1.3).

Thinnfeldia Feistmantelli, Johnston, Pap. Proc. Roy. Soc. Tas., 1895 (1896), fig. 2.

? *Thinnfeldia polymorpha*, Johnston, *ibid.*, p. 62, fig. 16.

(For fuller synonymy see Walkom, 1917, p. 17.)

The Tasmanian collections contain typical examples showing the bipinnate frond with dichotomous rachis and short obtuse pinnules with characteristic venation.

In some cases the rachis shows the transverse markings to which attention has been drawn previously (Walkom, 1917, p. 19), and, in addition, a number of vertically elongate scars (Fig. 4) up to 2 mm. by 1 mm.

Johnston himself called attention to the very close similarity between *T. polymorpha* and *T. obtusifolia*, and there is little doubt about this synonymy. He also inclined to refer some of the specimens he had previously named *Pecopteris caudata* (Geol. Tas., Pl. 26, f. 2, 6, 20) to *Thinnfeldia polymorpha*.

Thinnfeldia odontopteroides (Morris). (Fig. 5)

Thinnfeldia obtusifolia (pars), Johnston, Geol. Tas., 1888, Pl. 25, f. 7, 14 (*not* f. 3, 9).

(For fuller synonymy see Walkom, 1917, p. 19.)

This species appears to be particularly common in Tasmania. It shows considerable variation in size, the pinnules ranging from 4 to 10 mm. in length. A typical example is shown in Fig. 5.

On some of the specimens from Lord's Hill there is a secondary structure, possibly a mineral deposition, on parts of the pinnules and rachis. This structure gives to the specimen an appearance as of a reticulate venation, and is apparently responsible for specimen B 929 being labelled *Sphenozamites*.

Thinnfeldia lancifolia (Morris).

? *Neuropteris tasmaniensis*, Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), 171, Pl. 2, f. 2; Geol. Tas., 1888, Pl. 23, f. 2.

Pecopteris (*Thinnfeldia*) *odontopteroides* (pars), Johnston, Geol. Tas., 1888, Pl. 25, f. 1, 2, 4.

Thinnfeldia superba, Johnston, *ibid.*, Pl. 26, f. 4, 5.

? *Pecopteris odontopteroides*, Johnston, Pap. Proc. Roy. Soc. Tas., 1893 (1894), 173, Pl. 2, f. 1-5.

? *Thinnfeldia Buftoni*, Johnston, *ibid.*, 1895 (1896), 61, f. 18.

? Neuropteris tasmaniensis, Johnston, *ibid.*, 1895 (1896), f. 1.

(For fuller synonymy and description, see Walkom, 1917, p. 21.)

This species is easily distinguished from the other Thinnfeldias by the elongate pinnules, with a distinct midrib. It is of common occurrence in Tasmania.

The specimens figured by Johnston as *Neuropteris tasmaniensis* appear to belong to the present species.

JOHNSTONIA, n. gen.

This name is proposed for a group of peculiar fronds from the Mesozoic rocks of Tasmania. They are distinct in having a simple frond with dichotomously branched rachis; they are similar in this respect to species of *Thinnfeldia*. In *Johnstonia*, however, the lamina is continuous, with the margin entire or lobed to a varying extent, and the venation is distinct from that of *Thinnfeldia*. The name is proposed in honour of the late R. M. Johnston, who did so much of the pioneering work in science for Tasmania.

Frond simple, rachis dichotomously branched. Lamina with margin entire or lobed to varying degree. Veins at very acute angle to rachis, branching once or twice, occasionally more than twice.

Johnstonia coriacea (Johnston). (Figs. 6-8.)

Rhacophyllum coriaceum, Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), 170; Geol. Tas., 1888, Pl. 26, f. 9.

? Pecopteris caudata, Geol. Tas., 1888, Pl. 26, figs. 2, 8 only.

? Strzeleckia tenuifolia, Johnston, Pap. Proc. Roy. Soc. Tas., 1895 (1896), 58, fig. 8.

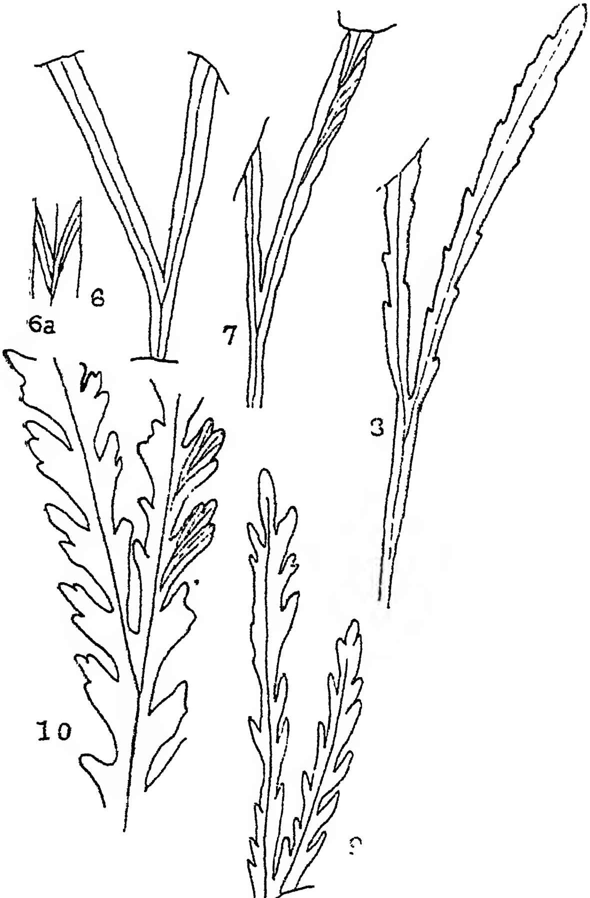
Frond dichotomously branched, the branches linear elongate, strap-shaped, with a prominent midvein and secondary veins, which divide usually once, and make a very acute angle with the midvein. Margins entire or slightly lobed.

Specimens attain a length up to 10 cm. above the point of dichotomy, and the breadth in larger specimens is 1 cm., though in general they are narrower than this.

This is the plant described and figured by Johnston under the name *Rhacophyllum coriaceum*, though it cannot be regarded as belonging to that genus as used by other authors.

Under the name *Strzeleckia tenuifolia*, Johnston figured a specimen which does not agree with his definition of the

genus, and which appears from his figure to be an incomplete example of the species he had described as *Rhacophyllum coriaceum*.



Figs. 6-8.—*Johnstonia coriacea* (Johnston). 6a, small portion enlarged to show venation. 6, 7 (X .6), 6a (X 1.3), 8 (nat. size).

Fig. 9.—*Johnstonia dentata*, n.sp.

Fig. 10.—*Johnstonia trilobita* (Johnston), slightly enlarged.

Two of the examples figured by Johnston as *Pecopteris caudata* (Geol. Tas., Pl. 26, figs. 2, 8), probably belong to the present species, but it is also possible that one of them (fig. 8) may be a small example of *Thinnfeldia odontopteroides*.

Johnstonia dentata, n.sp. (Fig. 9.)

Similar in habit and venation of *J. coriacea*, but with the lamina divided into distinct more or less acutely pointed segments.

It is possible that this may represent only a variation of *J. coriacea*. For the present, as the two are quite distinct in appearance, it seems an advantage to give them separate names.

Johnstonia trilobita (Johnston). (Fig. 10.)

Thinnfeldia trilobita, Johnston, Pap. Proc. Roy. Soc. Tas., 1885 (1886), 372; Geol. Tas., 1888, Pl. 24, fig. 6; Pl. 26, fig. 12.

This species was described by Johnston from Spring Bay as a *Thinnfeldia*, but it seems more closely allied to those specimens which have been here referred to *Johnstonia*. The frond is dichotomous, the branched rachis bearing pinnules attached by the whole of their decurrent bases. The pinnules at their termination are characterised by having three lobes. The venation appears to consist of a small number of veins arising from the branching of one (or ? two) veins leaving the rachis at an acute angle.

Linguifolium diemenense, n.sp. (Fig 11.)

? *Pecopteris caudata*, Johnston, Geol. Tas., 1888, Pl. 26, fig. 1 only.

? *Strzeleckia gangamopteroides*, Johnston, Pap. Proc. Roy. Soc. Tas., 1895 (1896), 58, figs. 5-7.

Thinnfeldia saligna, Feistmantel, Uhlonosné Utvary v Tas., 1890, 97, Pl. viii, f. 13.

Examples of simple leaves, gradually narrowing towards base, with entire margins, strong midrib and secondary veins at an acute angle to the midrib, curving outward and bifurcating once or twice, may be referred to Arber's genus *Linguifolium*, described from Rhætic and Jurassic rocks in New Zealand. These specimens differ from the Queensland species of *Phyllopteris* in the shape of the leaves and in the nature of the secondary venation. In proposing the genus *Linguifolium*, Arber suggested that all the Australian *Phyl-*

lopteris should be transferred to his genus, but it seemed to me that the Queensland species could better be retained in *Phyllopteris* (Walkom, 1919, p. 21). The present Tasmanian examples, however, appear to agree very well with Arber's description.

The secondary veins are wider apart, and have not such a pronounced outward curve as in the Queensland examples; the apex is acuminate, and the secondary veins are about 1 mm. apart.

It seems possible that some of these leaves are identical with those described by Johnston as *Strzeleckia gangamopteroides*, but in view of his description it is not possible to determine this positively. His description ran "no mid-"rib; nerves numerous, distinct, ascending from base, and "from the crowded midrib-like central series, at a very acute "angle to the margin, but never *anastomosing*." Whether his "crowded midrib-like central series" was really a midrib or not we cannot say, as unfortunately there is no record of the exact specimens from which his sketches were drawn.

One specimen figured by Johnston (Geol. Tas., Pl. 26, fig. 1), as *Pecopteris caudata* would also appear to be a synonym of the present species. Feistmantel (1890) referred this same specimen to *Thinnfeldia saligna*, Schenk.

Sphenopteris Morrisiana, Johnston.

Pap. Proc. Roy. Soc. Tas., 1895 (1896), 58, f. 14, 15.

Of this species I have seen only small fragments, but apparently the late R. M. Johnston had some large fronds, which he described in detail, believing that a number of the species previously described had been based on fragments from different parts of large fronds.

Pecopteris lunensis, Johnston.

Pap. Proc. Roy. Soc. Tas., 1893 (1894), 170, Pl. 1, figs. 5, 6, 7.

This species was described by Johnston from Ida Bay, near Southport, associated with *Vertebraria australis*. The latter species should be easily identified, and, if Johnston's determination is correct, *Pecopteris lunensis* is of Permian age.

Tæniopteris Morrisiana, Johnston. (Fig. 12.)

Pap. Proc. Roy. Soc. Tas., 1885 (1886), 375.

This species was described (but not figured) by Johnston from near Longford, associated with *Phœnicopsis elongatus* and *Cladophlebis australis.* The specimen figured here agrees with the description, being about 1.3 cm. wide, and having the veins about 1 mm. apart, and branching occasionally.

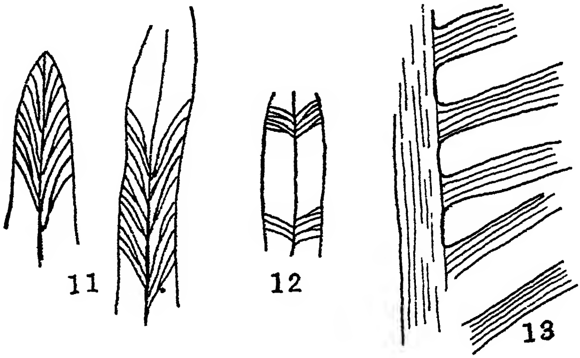


Fig. 11.—*Linguifolium diemenense*, n.sp.
Fig. 12.—*Tæniopteris Morrisiana*, Johnston (X .6).
Fig. 13.—*Pseudoctenis* sp.

Pterophyllum Strahani, Johnston.

Pap. Proc. Roy. Soc. Tas., 1886 (1887), 175, Pl. 1, f. 1, 1a; Geol. Tas., 1888, Pl. 28, f. 1, 1a.

Anomozamites Strahani, Feistmantel, Uhlonosné Utvary v Tas., 1890, 108, Tab. x, f. 1, 2.

This is a larger species than any I have yet examined from Australia, and may be compared with some of the large Indian forms such as *Nilssonia princeps* (Oldham and Morris), in which the pinnæ are 1 to 3.5 cm. wide, and the veins 0.5 to 0.8 mm. apart, but in *Nilssonia* the veins do not divide frequently as in the Tasmanian specimen.

Feistmantel referred the species to *Anomozamites*, but with only one or two specimens available, it is not easy to be sure of the correct generic position.

Pterophyllum risdonensis, Johnston.

I am unable to say whether *P. risdonensis*, described by Johnston (Pap. Proc. Roy. Soc. Tas., 1886 (1887), 175), is really distinct from *P. Strahani.* Johnston considered it so,

but the only distinction in his description is that *P. risdonensis* has the veins strong, not dichotomous, and only six in a pinna whereas in *P. Strahani* they are fine, dichotomous, and 8-16 in a pinna. The non-dichotomous veins of *P. risdonensis* suggest the possibility of it being a *Nilssonia.*

Pterophyllum ? dubia, Johnston.

Pap. Proc. Roy. Soc. Tas., 1886 (1887), 176, Pl. 3, f. 6; Geol. Tas., 1888, Pl. 27, f. 3.

Nilssonia polymorpha, Feistmantel, Uhloncsné Utvary v Tas., 1890, p. 107, Pl. ix, fig. 2.

It appears to me that Johnston's alternative suggestion, that this might be portion of a large *Tæniopteris,* was more correct than the placing of it in the genus *Pterophyllum.* Arber (1917, p. 36) has suggested that this fragment might belong to his genus *Linguifolium,* but I think Johnston's own alternative suggestion the more probable. It may be that it is portion of a frond of *Tæniopteris tasmanica,* which Johnston described (Pap. Proc. Roy. Soc. Tas., 1885 (1886), 375), but did not figure.

Feistmantel (1890) referred the fragment figured by Johnston to *Nilssonia polymorpha*, Schenk. but it is more probably a *Tæniopteris.*

? Pseudoctenis sp. (Fig. 13.)

One specimen (B 982) shows portion of a cycadean frond which in all probability belongs to *Pseudoctenis.* The rachis is 6 mm. wide, and is traversed by a number of longitudinal striations. The pinnæ are separate, at right angles to the rachis, or nearly so, about 3-5 mm. wide, and traversed each by about 4 parallel veins which occasionally bifurcate. In places, each vein has the appearance of being a double vein.

Ginkgoites digitata.

Cyclopteris australis, Johnston, Pap. Proc. Roy. Soc. Tas. 1886 (1887), 174, Pl. 3, f. 1; Geol. Tas., 1888, Pl. 27, f. 1.

The specimen described by Johnston shows a very close similarity to figured examples of *Ginkgoites digitata*, one of the common and widespread Jurassic species of the genus (Seward, 1919, p. 20, fig. 638; Walkom, 1917a, Pl. 1, fig. 3).

Feistmantel (1890, 112) transferred this to *Gingko* (*sic*) *australis.*

Ginkgoites salisburioides (Johnston).

Sagenopteris salisburioides, Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), 170, Pl. 1, f. 4, 4a; Geol. Tas., 1888, Pl. 28, f. 4, 4a.

Amongst the collections submitted to me the only example of this species was the one figured by Johnston (*loc. cit.*, fig. 4a). In this example I think that the veins do not anastomose, the apparent anastomosis being produced by a distinct wrinkling, which is almost parallel to the general direction of the veins in one half of the leaf, and makes an acute angle with the veins in the other half. Hence instead of being a *Sagenopteris* the specimen should be referred to *Ginkgoites*. This is further borne out by the other figure of Johnston's (fig. 4), which is apparently a more complete specimen and which is obviously a *Ginkgoites*. Having only seen portion of one specimen, I am not prepared to say whether or no this species is synonymous with *G. digitata*, but can only call attention to its similarity to some of the specimens which have been referred to this species from the Jurassic of Yorkshire and Scotland (see Seward, 1919, p. 17, figs. i, j). Had the specimen (fig. 4a) been the only one, one would have suggested comparison with *G. crassipes* from India (Seward and Sahni, 1920, Pl. 7, f. 74), and also perhaps the resemblance to some leaves referred to *Psygmophyllum* or allied genus.

Baiera tenuifolia, Johnston. (Figs. 14-16.)

Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), 176, Pl. 3, f. 2 *a* - *e*; Geol. Tas., 1888, Pl. 27, f. 2 *a* - *e*.

This is a species of similar type to *B. Lindleyana* (Schimper).

The breadth of the leaves does not appear to be greater than 2 mm., and they branch dichotomously a number of times. It also shows resemblance to *Czekanowskia microphylla*, which is not easily distinguished from *B. Lindleyana* in many cases.

Closely associated with *B. tenuifolia* in some cases are small rosette-shaped masses, each made up of about 12 elongate bodies radiating from a centre. These are indistinguishable from *Stachyopitys annularioides*, Shirley (see Walkom, 1917a, p. 13, Pl. 4), described from Lower Mesozoic Rocks in Queensland. There seems every probability that the two forms are connected, though I am not convinced that

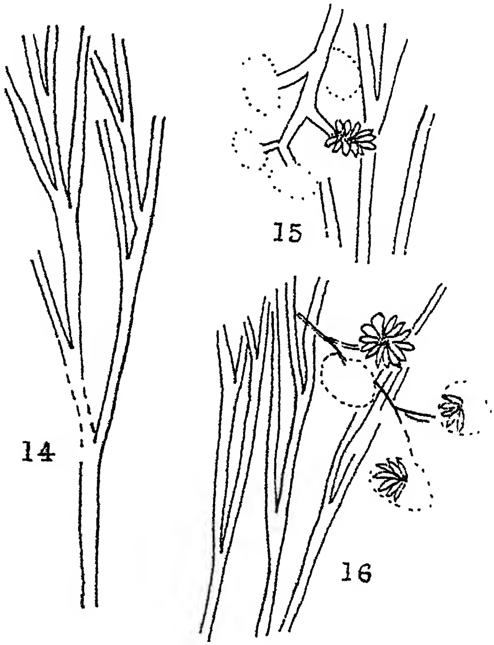


Fig. 14.—*Baiera tenuifolia* (Johnston).
Fig. 15.—*? Baiera tenuifolia.*
Fig. 16.—*? Baiera tenuifolia* (X 1.3).

there is actual connection in the specimens I have seen. I did not see any specimens similar to figs. 2b and 2c of Johnston.

Feistmantel (1890, 113) describes this as a new species, and refers it to *Trichopitys* (*T. Johnstoni*), but there does not seem to me to be sufficient evidence to justify this generic determination.

? Baiera bidens, Tenison-Woods.

Salisburia Hobartensis, Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), 177, Pl. 1, f. 2; Geol. Tas., 1888, Pl. 28, f. 2.

Gingko (*sic*) *Hobartensis*, Feistmantel, Uhlonosné Utvary v Tas., 1890, 112, Pl. x, fig. 6.

Johnston compares this with *Salisburia lepida*, Heer, and recognises that it is only a fragment of a leaf. He sug-

gests that the complete leaf would probably have from 6 to 7 lobes like the one he figured. This prompts the tentative reference to *Baiera bidens.*

Ginkgophyllum australis, Johnston.

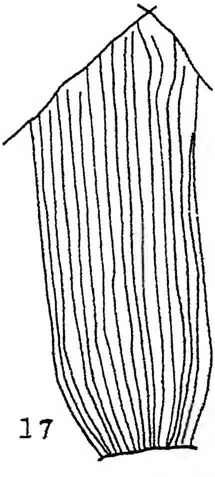
Pap. Proc. Roy. Soc. Tas., 1886 (1887), Pl. 3, f. 3; Geol. Tas., 1888, Pl. 27, f. 3.

I have not seen the specimens figured under this name, and am unable to suggest their affinities.

Phœnicopsis elongatus.

? *Zeugophyllites elongatus,* Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), 179.

Numerous long leaves, gradually tapering, 15 cm. long, 6 mm. broad, with 6-8 parallel veins, may be referred to this species. Somewhat wider examples, which may belong to the same species, are in the Launceston Museum: they are about 1.1 cm. wide, and have 12 parallel veins.



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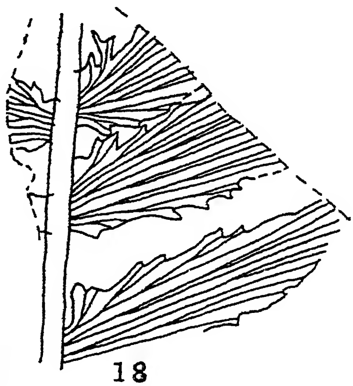

18

Fig. 17.—Cycadaceous leaf.
Fig. 18.—(? *Otozamites*) *Feistmantelii* (Johnston).

Cycadaceous leaf. (Fig. 17.)

The accompanying figure of a specimen (B 1045) from Lord's Hill is portion of an isolated cycadaceous leaf, figured here with the idea of calling attention to it in the hope that perhaps future collecting will bring to light more complete examples.

(*? Otozamites*) *Feistmantelii* (Johnston). (Fig. 18.)

Rhacopteris (?) *Feistmantelii*, Johnston, Pap. Proc. Roy. Soc. Tas., 1885 (1886), 368.

Sphenozamites Feistmantelli, Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), Pl. 4, f. 1, 2; Geol. Tas., 1888, Pl. 24, fig. 2.

This plant was described by Johnston in 1885 and ascribed by him to the genus *Rhacopteris*, though, at the same time, he called attention to a resemblance in venation to *Otozamites*. The next year he figured it, and referred it to *Sphenozamites* (?).

The venation is certainly similar to that of *Otozamites*, but the extremely irregular margins make it unlike any species I have met with, and I am unable satisfactorily to place it in any genus known to me.

Seeds (?).

On specimen B 979 there are a number of small round bodies, about 3 mm. in diameter, which are possibly the remains of seeds.

Lepidostrobus Muelleri, Johnston.

Pap. Proc. Roy. Soc. Tas., 1883 (1884), 225.

This specimen of a cone has a length of 10.5 cm., and is preserved in a block of sandstone. It has been described by Johnston, but of course should not be referred to the genus *Lepidostrobus*, which is confined to rocks of Palæozoic age. I am unable to determine its characters sufficiently well to place it generically.

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TASMANIAN *DISCOMYCETES.*

By L. Rodway, C.M.G.,

Government Botanist.

(Read 10th November, 1924.)

The students of Tasmanian Fungi have very insufficient means of becoming acquainted with described species, and, further, such a small number of those indigenous in the State have been described that there is fair reason to justify a paper to bring our knowledge up to date. It is probable that some, perhaps many, of those described as new may eventually be recognised to be identical with forms already named elsewhere, but if we wait till we shall commit no errors the purpose of this paper will not have been met. It is essentially one to afford a student an easy means of recognising the local species of the large fungus group known as *Discomycetes*. The only work already available to students is Cooke's *Handbook of Australian Fungi*, and the information in that book is too fragmentary, and often erroneous, to be of much assistance. The *Gymnoascaceæ* have been included at the end of the paper, though they belong to another group, *Plectomycetes*. The disc-fruiting fungi, which have adopted a parasitic habit, commonly known as Lichens, are excluded from convenience, and not from any supposition that they are genetically distinct. The *Histeriales* are almost continuous with some of the smaller plants of our group, but their distinction may soon be recognised.

Order *DISCOMYCETES.*

Ascophore an erect stipitate or sessile cup, plate, cushion, or club; the ascigerous layer or disc lining the upper or external surface, freely exposed on maturity.

The Order contains the following families:—

Phacideæ. Ascophore minute, sunk in the matrix usually blackish; at maturity splitting above into a linear or radiate fissure exposing the disc.

Sticteæ. Ascophore minute sunk in the matrix, urceolate then expanding; exciple very thin and whitish opening in a stellate manner exposing the disc, which is waxy clear coloured and pale.

PATELLAREÆ. Ascophore minute erumpent when quite young soon becoming superficial and often discoid, sessile glabrous, horny, or leathery often blackish.

DERMATÆ. Erumpent, corky coriaceous or horny; externally scurfy, usually cæspitose from a common stroma; colour black or dingy.

BULGAREÆ. Ascophore sessile or nearly so; gelatinous; horny when dry; turbinate or discoid, often bright coloured.

ASCOBOLEÆ. Ascophore minute, sessile, fleshy; asci projecting above the disc at maturity.

PEZIZÆ. Ascophore cup-shaped or discoid, often stipitate, fleshy or waxy; asci not projecting above the surface of the disc at maturity; often bright coloured.

HELVELLEÆ. Ascophore usually stalked, rarely minute and sessile; hymenial surface on a cushion, club, pitted or irregularly shaped body, exposed from the first except in *Cyttaria;* substance fleshy, rarely waxy or gelatinous.

GYMNOASCACEÆ. No defined ascophore. Asci forming an undefined plane.

Family PHACIDEÆ.

Ascophore usually minute, leathery, dark, more or less immersed; disc circular, at first immersed then exposed by the exciple splitting; disc exposed and gaping at maturity; spores 8, filiform and arranged in a fascicle.

Members of this family often resemble forms of the Order *Hysteriaceæ,* from which they differ by the ascophore being more fully exposed and not being of a carbonaceous character.

Coccomyces. Ascophore 3-4 angled, disc fuliginous.

Cerion. Ascophore peltate, disc crimson.

Colpoma. Ascophore oblong, black.

Coccomyces.

Ascophores immersed, minute, bursting at maturity in a stellate manner, the epidermis of the host connate with the exciple; when dry more or less closed and angular; disc waxy, protruding at maturity.

C. trigonous, Karsten. Ascophores black, 3-4 angled, about 0.5 mm. diameter.

On decolourised areas of dead Eucalyptus leaves.

Cerion.

Ascophore immersed bursting through the bark at maturity, the exciple black and usually stellate; disc waxy, crimson; spores multiseptate.

C. coccineum, Mass et Rod. Disc usually 2-3 mm. diameter, bright crimson.

On dead twigs.

f. album. Disc white.

Colpoma.

Ascophore immersed becoming superficial, oblong, black, scattered, opening in two lips, disc soft, pale protruding; spores septate.

C. eucalypti, n.s. Ascophores scattered, oblong, 1 mm. long, black. Paraphyses numerous, curved, exceeding the asci.

On dead leaves of *Euc. gigantea.*

Family STICTEÆ.

Ascophore minute, immersed, cup-shaped; disc waxy, light coloured.

Distinguished from *Phacideæ* by being of waxy consistence and of light colour throughout.

Stictis. Disc circular, margin white, stellate; spores filiform in a fascicle.

Nemacyclus. Disc elongated and narrow, bordered by two lips; spores in a fascicle.

Propolis. Disc roundish; spores shortly cylindric, obtuse, in two series.

Stictis.

Ascophore opening in a white stellate orifice; disc waxy; asci linear, 8-spored; spores filiform in a fascicle, septate when mature.

S. radiata, Pers. Margin white, stellate, mostly under 0.5 mm. diameter; disc at the base of the cup, waxy pale straw coloured.

On dead twigs.

Nemacyclus.

Ascophore elliptic-oblong, exposed by the formation of an elongated slit in the epidermis which forms two spurious lips; disc waxy, pallid; asci clavate, 8-spored; spores hyaline or pale yellow, filiform, arranged in a fascicle, continuous or septate, spores often breaking up while still in the ascus.

N. gilvus, Rod. Ascophore nearly circular, mostly under 1 mm. diameter; disc ochre.

On *Lepidosperma.*

Propolis.

Ascophore minute, immersed, closed at first when opening the rudimentary exciple not forming a distinct margin; disc round or elliptic almost plane light coloured; asci clavate, 8-spored; spores elongated, obtuse, hyaline, continuous, bi-seriate, paraphyses with septate branched tips.

P. faginea, Kars. Usually under 2 mm. diameter; disc shallow, waxy, white becoming darker; spores cylindric, obtuse, smooth, hyaline, continuous, 21-23 x 7-9μ.

On dead wood.

Family PATELLARIEÆ.

Ascophore minute, erumpent when quite young, soon becoming superficial and often discoid, sessile glabrous, subcoriaceous or horny, usually blackish.

Patinella. Spores 8 continuous, hyaline.
Patellea. Spores uniseptate, hyaline.
Karschia. Spores septate, brown.
Patellaria. Spores 2—many septate, hyaline.
Phacopsis. Spores continuous; parasitic on Lichens.

Patinella.

Ascophore minute, erumpent, sessile, plane, with a parenchymatous exciple which forms a delicate margin; black or dark; asci clavate, 8-spored; spores elongate, hyaline; continuous, irregularly bi-seriate.

P. tasmanica, Berk. Black, discoid, plane or concave mostly 1 mm. diameter; disc pale; spores oblong curved, about 12 μ. diameter.

Common on rails and other dead wood.

Patellea.

Ascophore erumpent soon quite superficial, sessile, circular, patellate, coriaceous, contracting more or less when dry, blackish; asci cylindrical, 8-spored; spores elliptic-oblong, hyaline, uniseptate, paraphyses present.

P. scutata, n.s. Circular, convex, 1 mm. diameter; disc paler than the exciple but becoming black; asci broadly clavate; spores oblong obtuse, uniseptate, hyaline, 16 x 5 μ.

On bark of *Bedfordia salicina.*

Karschia.

Ascophore sessile, erumpent, superficial, and plane when mature, black, waxy, becoming horny; asci clavate, 8-spored; spores oblong smooth brown, uniseptate; paraphyses septate, apex thickened and coloured.

K. atherospermæ, Mass. et Rod. Ascophores gregarious, black, about 0.5 mm. diameter, discoid; spores oblong nearly black obtuse, usually curved, 18-20 x 7-8 μ.

On dead leaves and twigs of *Atherosperma moschata.*

Patellaria.

Ascophore almost superficial from the first, discoid and nearly plane on maturity, blackish, somewhat coriaceous, margin not prominent; asci cylindric, 8-spored; spores elliptic to fusoid, hyaline, 2—many, septate; paraphyses present.

P. masseæ, Rod. Gregarious, sessile, concave then plane, dark green then black, 1-2 mm. diameter, margin thin, collapsing when dry; asci clavate, 8-spored, staining blue with iodine, 150 x 10 μ.; spores bi-seriate, oblong elliptic, 3-6 often 5 septate, hyaline, 18-22 x 5 μ.; paraphyses filiform, ramose, apex thickened.

> Massee says of this species:—Allied to *Patinella tasmanica* but distinguished by the larger size of the ascophore, also by the larger and many septate spores.

Phacopsis.

Ascophore parasitic on the apothecia of crustaceous lichens; pulvinate, dark chestnut brown, narrowed at the base; asci broadly cylindric, 8-spored; spores ellipsoid, continuous, hyaline, smooth; paraphyses numerous exceeding the asci; tips broad branched, brown, aglutinate, turning blue with iodine.

P. pulvinata, n.s. 0.2-0.4 mm. diameter, nearly spherical with a narrow base, nearly black; spores ellipsoid to oblong, hyaline, continuous, narrow at one end; 12 x 5 μ.

On dead wood.

Family DERMATEÆ.

Ascophores erumpent, sessile, or narrowed to a very short stem-like base, usually cæspitose and springing in numbers from a common stroma; corky or coriaceous, never gelatinous, blackish or brown, often scurfy or mealy extern-

ally; asci 4-8 spored; spores 1—many septate, or in some genera containing very numerous minute continuous spores, paraphyses present.

Cenangium. Spores continuous.

Cenangella. Spores uniseptate, hyaline.

Triplidiella. Spores black, 1-3 septate.

Cenangium.

Erumpent, often many ascophores arise from a common stroma, at first closed then becoming urceolate or patellate; coriaceous or somewhat horny; spores oblong, continuous hyaline.

C. furfuraceum, De Not. Dry and leathery, at first closed then expanding; margin continuing more or less incurved, entire; disc pale brown, externally densely covered with rust-coloured scurf or meal; 0.5-2 cm. diameter; asci clavate, 8-spored; spores oblong, hyaline, smooth, continuous, 6-12 x 2.5-3 μ.

On dead wood.

C. recurvum, n.s. Ascophores usually a few together on a common stroma, flat to convex, margin obtuse, dark chestnut-brown, externally paler glabrous, substance tough almost corky; disc when fresh bright yellow-brown; externally pale straw; spores continuous, hyaline, smooth or granular, paraphyses filiform, 12-16 x 4-7 μ.

Cenangella.

Ascophores cup-shaped and crowded, several arising from a common stroma, cartilaginous; asci cylindric, 8-spored; spores hyaline, smooth, uniseptate.

C. tasmanica, Rod. Purple, 1-3 mm. diameter; spores ellipsoid, uniseptate, 10-12 x 5 μ.; paraphyses filiform, often branched above.

On dead wood.

Triblidiella.

Densely cæspitose, corky, erumpent, black, arising from a common stroma, narrowed below; asci broadly cylindric, 8-spored; spores uniseriate, sooty black smooth, uniseptate or occasionally 3 septate; paraphyses filiform branched.

T. biconica, Rod. Ascophores about 1 mm. diameter; spores ellipsoid, ends subacute 17 - 7 μ.

Bursting through bark of *Phyllocladus rhomboidalis.*

Family BULGARIACEÆ.

Ascophores gelatinous soft or firm, cup-shaped to plane, stipitate, erumpent or superficial, cæspitose on a common stroma, sometimes free; spores continuous or septate, hyaline or coloured.

The family differs from *Dermateæ* in little beyond consistency.

Spores continuous.

Bulgariella. Black.

Ombrophila. Orange to purple or brown; externally smooth.

Orbilia. Bright coloured; externally cellular.

Spores septate.

Calloria. Uniseptate.

Coryne. Spores 2-many septate, hyaline.

Bulgariella.

Ascophore densely gelatinous, sessile, glabrous, plane or convex, open from the first, black; asci cylindric, 8-spored; spores uniseriate, elliptic, dark, continuous, smooth.

B. pulla, Karsten. Convex, black, sessile, patellate, 1-2 mm. diameter, often densely crowded; asci cylindric, spores dark brown to olive, nearly globose, 11 x 9 μ.

On rotting wood.

Ombrophila.

Ascophore firm gelatinous to cartilaginous when moist, rigid and horny when dry, more or less stipitate, disc concave to convex; asci cylindric, 8-spored; spores elliptic, continuous, smooth, hyaline.

Closely resembling other yellow Elf-cups, but distinguished by the more or less viscid surface when fresh.

O. aurantiaca, Mass. Ascophore orange-yellow, externally paler, margin revolute, convex, substipitate, up to 1 cm. diameter, glabrous; asci cylindric; spores uniseriate, hyaline, elliptic, 10-12 x 7-8 μ., continuous.

On stem of *Dicksonia antarctica.*

O. discoidea, n.s. Gregarious, plane to convex, of a firm gelatinous consistency, sessile, discoid, mostly 2-3 mm. diameter, disc orange, margin paler, translucent, exciple rather prominent parenchymatous; asci 60-80 μ.; 8-spored, spores narrow-oblong almost linear, hyaline, smooth, 8 x 2 μ.; paraphyses filiform.

On moss and dead wood.

O. bulgarioides, Sacc. Ascophores gregarious, cup-shaped to concave, undulate, gelatinous, yellow, becoming umber-brown when dry, pellucid, externally mealy; sessile to shortly stipitate, stem dark, 0.5-2 mm.; spores narrow-oblong, hyaline, continuous, smooth, 6 x 1.5 μ.

On rotting wood.

O. nigripes (Pers.). Ascophores cartilaginous when fresh, concavo-convex, undulate to plane 1-3 mm. diameter, disc crimson-orange, surface mucilaginous, lower surface and stalk black, stem about as long as diameter of the disc; asci cylindric; spores narrow oblong, 8 x 1.5 μ., hyaline, smooth; paraphyses filiform straight, slightly thickened towards the apex. Resembling *Helotium citrinum.*

On rotting wood, chiefly on the ends of logs.

O. crenulata, n.s. Sessile, flat, discoid, rather undulate, dingy orange-yellow, 2-4 mm., margin thick and strongly crenated; externally nodulose otherwise glabrous, substance cartilaginous; asci clavate, 8-spored; spores biseriate fusiform; smooth, hyaline, 23 x 4 μ.

On dead wood.

Orbilia.

Ascophore gelatinous, sessile, attached by a central point, globose at first then expanding into a flat disc above, at first the margins are connected by a thin white membrane covering the disc, always of a bright colour, exciple of large cells; asci cylindric, 8-spored; spores uniseriate, hyaline, smooth, continuous.

The spherical ascophore with a small white membrane in the middle has the appearance of an eye.

O. crystallina, Rod. Globose and closely cæspitose, bases more or less confluent and several ascophores arising from a common stroma, 1-2 mm. diameter, surface crystalline with large prominent, pellucid, cells; disc at first covered by a delicate white membrane; as it expands the membrane bursts in the middle and remains as a toothed margin; spores elliptic with acute ends, 18-25 x 7-8 μ.

Amongst dead leaves. Much the appearance of *Humaria muelleri.*

Calloria.

Ascophore somewhat gelatinous, more or less pellucid when dry; small, subglobose at first becoming plane to convex, mostly sessile and fixed by a central point, erumpent or

superficial, glabrous, bright coloured; asci cylindric, 8-spored; spores uniseriate, hyaline, smooth; paraphyses present.

C. tasmanica, Rod. Ascophore plane on a short stalk, mostly 1-2 mm. diameter, dull ochre-yellow; spores narrow oblong, 8 x 1 μ.

On stem of *Dicksonia antarctica.*

Coryne.

Ascophore gelatinous, sessile or narrowed below into a short stem-like base, often many arising from the same stroma; disc plane; glabrous; asci cylindric, 8-spored; spores hyaline at length, 2—many septate.

C. sarcoides, Jacq. Cæspitose, gelatinous, red-purple, up to 1 cm. diameter, erumpent; spores ellipsoid, 2—many septate, 15-18 x 4.5 μ.; paraphyses clubbed at the apex.

Conidial form similar but without the expanded disc, and commonly referred to *Tremela.*

Family ASCOBOLEÆ.

Ascophore fleshy or rather gelatinous; disc plane or convex rough with the projecting tips of the asci at maturity; exciple parenchymatous; cortical cells large irregularly polygonal; asci usually broadly clavate, dehiscing by an apical operculum; 8—many spored; spores continuous, elongated, rarely globose, hyaline or coloured; paraphyses present. Mostly growing on decomposing leaves or animal refuse. The plants are minute and delicate.

Ascobolus. Spores 8, dark purple.

Ascophanus. Spores 8, hyaline.

Ascobolus.

Ascophore soft and translucent when fresh; disc plane or convex at maturity studded with the tips of protruding asci, externally glabrous or pilose; spores elliptical, at first colourless then dark purple or brown, generally rugulose at maturity.

A. furfuraceus, Pers. Ascophore pale yellowish-green; externally densely scurfy; spores elliptical, purple, at maturity longitudinally furrowed, 20-27 x 10-11 μ.

On animal rejecta.

A. glaber, Pers. Ascophore glabrous, up to 1 mm. diameter, reddish purple or brown; spores elliptical, obtuse, deep purple, usually longitudinally furrowed, 26 x 13 μ.

On animal rejecta.

A. barbatus, Mass. et Crossl. Disc crimson, externally paler, pilose, the hairs brown, thick-walled septate, conical, pointed, smooth, 80-130 x 10-12 μ., largest and most abundant near the margin; asci cylindric, apex rounded; spores elliptical, obtuse, smooth, hyaline for a long time then the epispore becomes violet and finally violet-brown and marked with delicate anastomosing lines, 16-18 x 9 μ.

On cow dung.

A. immersus, Pers. Erumpent and not entirely exposed; disc expanded, plane, yellowish-green and watery 0.5-0.7 diameter; externally minutely hairy, the hairs scattered or fasciculate; spores elliptic-oblong, smooth, continuous, hyaline, then purple and lastly brown; epispore sometimes longitudinally cracked, 50-70 x 35-45 μ.

On animal excreta.

A. archeri, Berk. Plane-convex externally pruinose, livid-green; spores elliptic, smooth, purple, 12 x 6 μ.

On excreta of small marsupials.

A. nitidus, Rod. Discoid, attached by a short slender stem, pale, dull, greenish-ochre, waxy, smooth; asci pyriform, 8-spored; spores in an irregular group, oblong, sooty-black, smooth, uniseptate, 10 x 6 μ.

On rotting *Poria.*

Ascophanus.

Ascophore somewhat fleshy, sessile, the disc becoming plane; externally glabrous or pilose; exciple parenchymatous; asci broadly clavate to ovate, 8-spored; spores hyaline, free, elongated.

A. equinus, Mass. Orange to tawny, margin smooth, sparely clothed externally with thick-walled, pointed, aseptate hairs, which are more or less swollen at the base, hyaline or with a yellow tinge; about 200 μ. long; asci cylindric, curved, 8-spored; spores irregularly biseriate, hyaline, smooth, continuous, elliptical, obtuse, 20 x 12 μ.

On horse dung.

Family PEZIZÆ.

Superficial, rarely erumpent; sessile or stalked, fleshy or waxy, never gelatinous, cartilaginous, nor corky, the hypothece and exciple usually formed of interwoven hyphæ rarely parenchymatous; disc cupulate, concave to convex; asci not protruding, generally cylindric; spores variously marked or smooth, continuous.

The family is very large with no well-marked breaks by which convenient groups may be isolated. In most systematic works they are divided into three lots:—

Section I.—GLABRATÆ. Ascophore glabrous, usually small and growing on dead or living plants.

Section II.—VESTITÆ. Ascophore hirsute or pilose or seated on a subiculum.

Section III.—CARNOSÆ. Ascophore often scurfy externally; from minute to very large, fleshy; growing on the ground.

There are no clear lines of demarkation, but with reasonable acquaintance the student will soon learn the distinctive features.

Section I.—GLABRATÆ.

Pseudopeziza. Ascophore waxy, erumpent.

Mollisia. Ascophore sessile, superficial, waxy; exciple parenchymatous; spores continuous or many septate.

Belonidium. Ascophore sessile, spores 3—many septate.

Helotium. Ascophore firm, fleshy, sessile or shortly stipitate, glabrous, margin entire, exciple of closely woven hyphæ.

Phialea. Similar to *Helotium*, but more stalked.

Pseudohelotium. Ascophore plane pellucid, externally downy, asci linear, spores oblong, hyaline continuous.

Cyathicula. Margin of the ascophore more or less toothed; sessile or shortly stipitate; spores continuous or septate.

Ciboria. Ascophore dark on a long slender stalk.

Sclerotinia. Ascophore on a long slender stem springing from a sclerotium.

Chlorosplenium. Ascophore concavo-convex, thin membranous, stalked, blue-green, and staining the wood.

Pseudopeziza.

Ascophore formed in the substance of the host, bursting through the epidermis and forming a superficial, hyaline cushion; exciple parenchymatous; asci narrow, 4-8 spored; spores smooth, hyaline, narrowly elliptic to fusiform, continuous or 1 septate.

P. trifolii, Fckl. Clustered on dark spots on the leaves, dingy yellow glabrous, about 0.4 mm. diameter; spores 10-15 x 5-6 μ. Paraphyses rather stout.

On clover leaves.

P. medicaginis, Sacc. On discoloured spots on fading leaves, yellowish-brown, thin and delicate, glabrous 0.4 mm. diameter; spores 8-11 x 4-5 μ.; paraphyses hyaline, slender, slightly thickened at the tips.

On leaves of *Medicago sativa.*

P. casuarineæ, Rod. Subcutaneous but soon bursting through the epidermis and forming a small cushion bearing numerous conidiophores (*Glocosporium*); subsequently the pulvinus extends, asci are formed and the formation of conidia ceases. A mature pulvinus is oblong 0.5-1 mm. in long diameter, dark red-brown of a tough fleshy consistency. Conidia hyaline, broadly oblong; asci cylindric, 8-spored; spores broadly oblong with very obtuse ends, hyaline, 17 x 8 μ.

On ultimate branchlets of *Casuarinia distyla* and *C. quadrivalvis*, causing yellowing of the segments.

P. geranii, n.s. Ascophores on the upper surface of the leaves of *Geranium pilosum* and allied species causing a yellowing of the leaf 0.5 mm. diameter, erumpent, brown; asci small, narrow-cylindric, 4-spored; spores uniseriate, elliptic, hyaline, smooth, 12 x 6 μ.

Mollisia.

Ascophore superficial, sessile, and attached by a broad surface, glabrous or minutely pubescent, small to minute, of a waxy watery consistency, cortex parenchymatous, hypothece of large brown parenchymatous cells; asci cylindric-clavate, 4-8 spored; spores irregularly biseriate, elongated; narrowly elliptic or fusoid, smooth, hyaline, continuous or uniseptate.

M. cineria, Karst. Ascophore plane when mature 1-2 mm. diameter, waxy-fleshy, livid grey, not contorted when dry, margin white, externally delicately pruinose, dark; asci cylindric, 8-spored, spores narrow-elliptic, ends obtuse, straight or slightly curved, 6-10 x 1.5-3 μ.

Common on dead wood.

M. undulata, Rod. Soft waxy becoming hard when dry, sessile, broadly affixed, concavo-discoid, undulate, 5-8 mm. diameter, livid-grey, turning black when dry; externally black; spores narrow-oblong 6 x 1.5 μ.; margin not white; collapsing when dry.

M. ellipsospora, n.s. Plano-concave, attached by nearly the whole of the under surface, 1-3 mm. diameter; disc

ochraceous, not collapsing when dry, margin thick, black; exterior surface black; spores ellipsoid, hyaline, smooth, 16 x 6 μ.

On rotting wood.

M. melaleuca, Sacc. Convex and contorted, soft waxy, disc white, 2-4 mm. diameter, margin not thickened, externally brown; spores narrow-oblong, 12 x 2 μ.

On dead wood.

M. notofagi, n.s. Ascophore peltate, sessile, but attached by a narrow centre, soft waxy livid-grey when fresh, nearly black when dry; 0.3 mm. diameter; margin black, verruculose; externally striate by radiate black lines; spores hyaline, smooth, oblong, 10 x 4 μ.; paraphyses filiform with clavate tips.

On dead leaves of *Notofagus cunninghami.*

M. ochro-nigra, n.s. Ascophore sessile, plane, 2-4 mm. diameter. waxy, disc pale brown towards livid; externally black; spores narrow-oblong, hyaline, smooth, obtuse, curved, 17 x 3; near *M. undulata.*

On dead wood.

M. verrucosa, n.s. Sessile but attached by a narrow base, concave-undulate, waxy-fleshy; disc pale straw coloured to dull green, mostly 5 mm. diameter; margin thick, chestnut-brown; external surface verrucose becoming black towards the centre; asci cylindric; spores fusiform, acute, hyaline, smooth, often curved, 24 x 4-5 μ.

On dead sticks amongst moss, paraphyses long, slender, with globose tips.

M. carneo-alba, n.s. Sessile, convex, irregularly undulate, white to pink, delicately waxy, margin not thickened; externally pale smooth or minutely pruinose; spores oblong, very obtuse. hyaline, verruculose, 17 x 8 μ., paraphyses few, slender, filiform, tip much curved.

On rotting wood.

M. subglobosa, n.s. Minute, discoid to convex, pale then smoky-livid to dull green or dull brown, soft waxy, sessile, margin pale, externally black; asci cylindric; spores hyaline, smooth, subglobose to broadly elliptic, 4-6 x 4-5 μ.

On dead wood. Amongst *Nectria pulvini.*

Helotium.

Ascophore shortly stalked or attached by a central point, small seldom exceeding 3 mm. diameter, at first closed then expanding and exposing the disc; glabrous, margin

entire, exciple of interwoven hyphæ, hypothece hyaline; asci narrow-cylindric, 8-spored; spores hyaline, smooth, elongated, continuous or uniseptate.

Growing on dead wood which distinguishes it from the small *Carnosæ*.

H. citrinum, Fries. Usually crowded, sometimes confluent, plane, glabrous, firm, fleshy, light orange-yellow becoming darker when dry; stem short, externally paler, mostly about 2 mm. diameter; asci with a long crooked pedicel; spores hyaline, continuous, elliptical, 9-12 x 3-4 μ.

Very common on dead wood.

H. claro-flavum, Berk. Gregarious, sessile, and attached by a central point, plane when mature; clear lemon-yellow, externally paler, irregular, firm, mostly under 1 mm. diameter; spores hyaline, continuous, straight, elliptical, obtuse, 7-10 x 2.5-3 μ.

On dead wood.

H. gratum, Berk. Ascophore shortly stalked, dull light straw, translucent when fresh, margin upturned obtuse, externally mealy, 1 mm. diameter; spores elliptic, smooth, hyaline, obtuse, 9-10 x 3 μ.

On dead wood.

H. sessile, Rod. Ascophore sessile, arising from a hyphal base concave to convex; pale yellow ochre externally and minutely pruinose, mostly under 1 mm. diameter; spores elliptic, hyaline, smooth, uniseptate, 17 x 8 μ.

H. patæriforme, Berk. Ascophore sessile, rarely stalked, concave, lobed, honey-coloured, translucent, externally slightly rugose and tomentose beneath, up to 4 mm. diameter; spores fusiform, usually slightly curved, hyaline, smooth, at first continuous then 1-2 septate, 28 x 4 μ.

H. striatum, Rod. Ascophore sessile or shortly stalked; soft fleshy, concave, pale cinereous becoming ochre when dry, 1-2 mm. diameter, externally sooty-brown, glabrous, striate; spores oblong, very obtuse, hyaline, smooth, 6 x 3.

Intermediate between *Mollisia* and *Helotium*.

H. microsporium, Rod. Ascophore shortly stalked, soft fleshy, disc livid to nearly white, externally smooth; spores broadly oblong, very obtuse, hyaline, smooth, continuous, 4.5 x 2 μ.

Intermediate between *Helotium*, *Mollisia*, and *Phialea*.

H. molle, n.s. Ascophore sessile, concave-undulate, with upturned margin soft, honey-coloured, 0.2-1 mm. diameter;

margin obtuse, pale straw, externally minutely furfuraceous; spores smooth. hyaline, oblong-fusiform, curved, obtuse; 8-12 x 2-3 μ.

Phialea.

Ascophore concave to convex membranous to rather fleshy, externally glabrous or pruinose, on a short slender stem; spores hyaline, smooth, continuous.

Commonly on dead leaves, continuous with *Helotium*, *from which it differs in a greater tendency to develop a stalk.*

P. berggrenii, C. et P. Concave, almost membranous, on a slender stalk; disc livid yellow, 1-3 mm. diameter, externally brown, minutely pruinose; spores oblong, 10-15 x 3-5 μ.

P. ceratina, Berk. Peltate when mature, about 1-2 mm. diameter, disc horny, brown; externally pubescent, stem short, slender; spores oblong, 19-22 x 4-5 μ.

P. byssogena, Berk. Cup-shaped, 1-1.5 mm. diameter, pale ochre-brown; externally delicately pruinose; stem slender, 2 mm., arising from radiating mycelial strands; spores oblong-elliptic, 8-9 x 2-3.

Usually growing on dead wood.

P. epiphyllum, Fries. Disc plane to convex from golden yellow to ochre, becoming darker with age, 2-3 mm.; external surface and stem delicately pruinose; stem slender from very short to 3 mm.; spores narrow-oblong, 13-20 x 4-5, continuous but ultimately uniseptate.

P. notofagi, Rod. Ascophore arising from a flat, black, sclerotial patch on the back of a leaf; disc plane or concave, dull horny brown, 1-2 mm. diameter; asci broadly cylindric; spores biseriate, oblong, acute, hyaline, smooth, 25 x 3 μ.; paraphyses with an enlarged brown nodulose tip.

On dead leaves of *Notofagus gunnii.*

P. prasinum, Mass. Disc plane with an upturned margin, 0.5-1 mm. diameter; yellowish-green, usually reddish-brown with age; externally somewhat furfuraceous to glabrous, spores 6-7 x 2-2.5 μ., oblong; paraphyses with thickened yellow green tips.

On dead wood.

P. subciboria, n.s. Ascophore discoid, thin concave to plane; disc white, becoming livid with age, 1-2 mm. diameter, stem short, slender, black; external surface black, verrucose or wrinkled; spores oblong, smooth, hyaline, 10 x 2.5 μ.

Cyathicula.

Ascophore firm to waxy, sessile or shortly stalked, glabrous with the exception of a single row of teeth round the margin; asci cylindric, 8-spored; spores hyaline, mostly continuous oblong.

C. multicuspidata, Rod. Cup-shaped, sessile, white, delicate, about 1 mm. diameter, smooth, but the margin armed with compound lobes; spores narrow oblong, granular, 15-20 x 4 μ.

On dead rhachis of *Dicksonia antarctica.*

C. granulosa, n.s. Sessile, peltate, orange, 2-4 mm. diameter, fleshy; disc slightly granular; margin acute with a line of minute pale teeth composed of agglutinated hyphæ, externally granular; asci broadly clavate, 8-spored; spores irregularly biseriate, smooth, hyaline, continuous, narrow elliptic, 28 x 9 μ.

On dead wood.

Ciboria.

Ascophore concavo-convex thin, fleshy; normally long-stalked and emerging from cracks in dead wood; externally smooth or mealy or in some cases bearing few dark bristles; asci cylindric, 8-spored; spores hyaline, smooth, oblong to fusiform.

C. firma, Pers. Cups concavo-convex, black or nearly so throughout, rather tough, glabrous, 4-10 mm. diameter; stem very long and slender; spores oblong, 17 x 3.5μ., when old 1—many septate.

C. olivacea, n.s. Disc convex, repand, dark olive green on a rather short stalk, soft fleshy almost waxy, 3-5 mm. diameter; externally black, ribbed but not hairy; spores uniseriate, fusiform, but with obtuse ends, hyaline, continuous, 8 x 2.

C. strigosa, n.n. *Dasyscypha eucalypti, Berk.* Disc concave to convex, fleshy yellow when fresh, dark when old and dry, 2-6 mm. diameter; externally pale livid then dark; armed externally especially on the margin with few dark stiff bristles; stem thin, long, black, to very short; spores 16 x 4-5. When the ascophore arises in a crevice and is erumpent the stem is very long; when growing in shade on dead leaves or twigs it is medium, and when on smooth bark it is almost obsolete; this also applies to *C. firma.*

C. ochracea, Mass. Ascophore glabrous; plane to convex with a drooping margin; fleshy; everywhere from ochre to ochre-brown, 3 mm. diameter; stem about 1 cm., spores oblong, 10-15 x 2-5 μ.

Pseudohelotium.

Ascophore concave to peltate, sessile or nearly so, waxy, externally pilose to pruinose; spores continuous hyaline, oblong.

Very close to *Helotium.*

P. hyalinum, Pers. Discoid, sessile, white to cream coloured, brown when dry, soft fleshy pellucid when fresh; externally minutely pruinose; spores 16-24 x 2-5 μ.

P. undulatum, n.s. Ascophore discoid distorted, undulate when dry, tough, fleshy, white, becoming ochre when dry, subsessile; externally slightly downy; asci very slender, 8-spored; spores uniseriate, ellipsoid, hyaline, smooth, acutely pointed at both ends, 12-14 x 6 μ.

Belonidium.

Ascophore superficial, sessile, minute; exciple parenchymatous, glabrous; asci narrow cylindric, 8-spored; spores biseriate, fusiform, smooth, hyaline, 3—many septate.

On living and dead plants.

Differing from *Mollisia* in the many septate spores.

B. araneosum, Berk. Ascophore convex, seated upon creeping threads, peltate or convex, orange-yellow; spores narrow, fusiform at maturity, many septate, 50-60 μ.

B. furfuraceum, n.s. Ascophore plane pale-straw coloured, 0.2-0.4 mm. diameter, waxy, externally furfuraceous; spores narrow fusiform, multi-septate, 48-60 x 3 μ.

B. viscosum, n.s. Cæspitose often confluent, sessile, convex, orange-crimson, waxy, 1-2 mm. diameter, viscid; spores narrow fusiform, hyaline, smooth, mostly 7 septate, 40-50 x 2 μ.

Sclerotinia.

Ascophores springing from a sclerotium disc plane or nearly so, fleshy, glabrous; stem long and slender; asci cylindric, 8-spored; spores uniseriate, hyaline, smooth, continuous.

"Close to Ciboria, differing in growing from a sclero-
"tium." Massee.

S. dubium, McAlpine and Rod. Ascophore chestnut-brown, plane to concave, thin, mostly 4 mm. diameter, stem 1-2 cm. long, slender, wavy; spores oblong, obtuse, 12 x 4-5 μ. Sclerotium subglobose, 1 cm. diameter.

S. sclerotiorum, Mass. Solitary or few together growing from a black sclerotium, concave to convex, margin entire, glabrous, thin, rather firm, pale brown, 3-7 mm. broad; stem slender, 1-3 cm. long; spores elliptic, 9-13 x 4-6 μ.

Sclerotium in living carrot and other cultivated vegetables.

Chlorosplenium.

Ascophore on a short slender stalk, tough and pliant, concave, membranous, glabrous, dark blue-green; asci narrow clavate, 8-spored; spores hyaline, continuous or septate, elongated.

C. æruginosum, De Not. The entire plant dark blue green; disc plane undulate, 2-5 mm. diameter; stem usually short, sometimes 1 cm. long, spores fusiform, 10-14 x 3 μ.

On dead wood, which it stains.

Section II.—VESTITÆ.

Tapesia. Ascophores gregarious, growing on a white layer of mycelium on the under surface of rotting wood.

Erinella. Ascophores minute, 3—many septate.

Trichopeziza. Ascophore minute, globose, densely clothed with stiff yellow hairs.

Lachnea. Usually crimson, clothed externally with rigid brown hairs.

Dasyscypha. Ascophore small, shortly stalked, externally woolly hairy.

Geopyxis. Ascophore large, cup-shaped on a fairly long stalk.

Sepultaria. Ascophore large, subterranean and globose; emerging from the ground at maturity and splitting irregularly at the apex.

Tapesia.

Ascophore minute, thin, sessile, pilose or downy, seated on a spreading subiculum formed of branched interwoven hyphæ; asci narrow clavate, 8-spored; spores irregularly biseriate, smooth, hyaline, continuous or septate.

T. epitephra, Berk. White to pale ochre, gregarious, about 0.3 mm.; spores continuous.

Erinella.

Ascophore minute sessile or shortly stalked, plane; externally pilose; asci cylindric, 8-spored; spores hyaline, narrow, 3—many septate.

E. apala, Mass. Gregarious, seldom exceeding 0.5 mm. diameter, sessile or shortly stalked; disc yellow-umber; externally very tomentose, white; spores filiform arranged in a fascicle, 3-7 septate when mature.

On dead *Juncus.*

Trichopeziza.

Ascophore at first globose, then peltate, sessile, minute; externally hairy or with a ciliate margin; asci broadly cylindric, 8-spored; spores fusiform, continuous, hyaline.

T. sphærula, Sacc. Cups sessile, seldom exceeding 0.5 mm., often not expanding but discharging spores through an apical pore, bright yellow, sprinkled externally with divergent simple stiff hairs, spores narrow oblong, obtuse, 15 x 3 μ.

On bark of *Casuarina.*

Lachnea.

Ascophore sessile, plane when mature, fleshy, disc usually dark red, rarely pale or grey; externally brown and armed, principally towards the margin, by long brown stiff septate bristles; asci cylindric, 8-spored; spores obliquely uniseriate, hyaline, continuous, elliptic, obtuse, smooth or the surface marked with nodules or reticulations.

Colour is not always dependable. Many lose their red colour when dry and do not recover it when restored.

Key to Lachnea.

Spores smooth.
- Habitat fimicole.
  - *coprinaria*, bristles simple.
  - *stercoria*, some bristles stellate.
- Habitat on wood or ground.
  - *setosa*, bristles long overarching when dry.
  - *carneo-sanguinea*, spores 10 μ. broad.
  - *hybridea*, bristles clustered, spores 15 μ., broad.

Spores eventually verruculose.
  - *scutellata*, long bristles, 500-600 μ. long.
  - *umbrorum*, long bristles, 250-360 μ. long.

Spores verrucose.
  - *margaritacea*, bristles short, 150 μ. long.
  - *hirta*, on ground, bristles 300 μ. long.
  - *badioberbis*, on wood, bristles 600-1,000 μ. long.

L. coprinaria, Phil. Disc plane orange-red to scarlet, 5-10 mm. diameter, margin more or less erect, fringed with

thick walled, tapering, straight septate pale or brown hairs, 300-500 x 9-12 μ., cortex parenchymatous; spores smooth, elliptic, ends obtuse, 17-19 x 9 μ.

On cow dung.

L. stercorea, Gill. Disc plane, dingy red to orange, externally paler and pilose, 2-4 mm. diameter; marginal bristles thick walled, base often bulbous and branched, bristles below the margin stellate; spores smooth, elliptical, obtuse, 17-20 x 8-9 μ.

L. setosa, Phil. Disc concave, orange-red, 3-6 mm., externally pilose, the brown bristles numerous and very long, when dry closing over the disc; spores elliptic, obtuse, smooth, 16-20 x 8-10 μ.

On dead wood.

L. carneo-sanguinea, Phil. Disc plane with an erect margin, 3-5 mm. diameter, deep red; externally pale brown, densely clothed with erect, rigid, brown bristles which form an erect fringe round the margin; bristles 50-120 x 9-12 μ.; spores elliptical, obtuse, continuous, hyaline, smooth, 17-20 x 9-10 μ.

On the ground.

L. hybrida, Phil. Disc plane, 6-12 mm. diameter, yellowish to red-yellow, externally dingy ochraceous and clad with small clusters of short thick-walled septate bristles; spores broadly elliptic, obtuse, smooth, 25 x 15 μ.

On dead wood.

L. scutellata, Gill. Plane, deep red, 3-8 mm. diameter, externally paler; bristles 300-600 μ.; spores hyaline, elliptic, obtuse, smooth till mature then verruculose, 18-25 x 11-14 μ.

On dead wood.

L. umbrorum, Gill. Plane, nearly the whole of the external surface bound down to the earth by dense hyphal growth, leaving only a narrow margin free; yellow-crimson, becoming yellow when dry; bristles short mostly under 250 μ.; spores broadly elliptic, very obtuse, smooth till rather old, then becoming minutely verruculose; 22 x 12 μ.

L. margaritacea, Berk. Disc plane vermilion, with a recurved margin, 5-7 mm. diameter; externally armed with relatively short bristles, longest about 150 μ. long; spores elliptical, coarsely verrucose, 24-27 x 12-14 μ. Very like *L. hirta*, but growing on wood and with a rougher epispore.

L. hirta, Gill. Disc plane but the margin remaining incurved, deep red, externally paler and armed with long

rigid brown hairs, 250-350 μ. long; spores at first smooth, becoming rather coarsely warted at maturity, 18-22 x 8-11 μ.

Growing on the ground, rarely on wood.

L. badioberbis, *Berk.* Disc plane, smoky orange to pale umber, 3 mm. diameter, externally paler, copiously armed with long brown bristles 600-1,000 long; spores broadly elliptic, 22 x 12 μ., coarsely verrucose.

On dead wood.

Dasyscypha.

Ascophore minute, shortly stipitate or sessile, concave to plane, thin and delicate in texture, externally pilose, hairs cottony; asci clavate 8-spored; spores irregularly bi-seriate, hyaline, smooth, narrow, continuous; paraphyses lanceolate and acute or cylindric, often longer than the asci, growing on wood.

D. virginea, *Fckl.* Disc concave to nearly plane on a short thick stem, margin upturned, white throughout usually under 1 mm. diameter, externally densely pubescent below and towards the margin armed with rigid white spreading septate hairs; spores oblong continuous, 6 x 2 μ.

Common on dead wood.

D. lachnoderma, *Berk.* Disc concave, warm-orange, mostly 1-2 mm. diameter, externally densely covered with short hairs, the marginal ones not long and spreading; margin involute; stem short slender usually dark; spores slender fusiform, curved, smooth, continuous, 18-25 x 2 μ.

D. candida, *n.s.* Ascophore white about 0.3 mm. diameter on a slender stalk of the same length, externally closely beset with short cylindric, obtuse, hairs; spores hyaline, smooth, 8-12 x 3 mm.

On dead wood. Larger spores and a different vestiture as in *D. virginea.*

D. pterydophylla, *Rod.* Disc cupulate on a short slender hairy stem, lemon yellow throughout, about 0.3 mm. diameter; externally armed with short rigid yellow hairs; margin incurved; spores narrow fusiform, hyaline, smooth, continuous, 16 x 1.5 μ.

On dead stipe of *Dicksonia antarctica.*

D. ovina, *Rod.* Superficial or partially erumpent, dull brown throughout, sessile, concave, margin inflexed and paler, 1-2 mm.; externally with a dense vestiture of short brown woolly hairs; spores broadly elliptic, smooth, hyaline, but turning brown, 14 x 8; paraphyses slender, with clavate olive tips.

Geopyxis.

Ascophore cup-shaped to nearly plane on a relatively long stem; disc broad fleshy; externally pilose, downy, scurfy or glabrous; stem slender smooth; asci cylindric, 8-spored; spores obliquely uniseriate, hyaline, continuous, elongated.

On ground, rarely on wood. Equally referable to the *Carnosæ.*

G. coccinea, Mass. Ascophore chalice-shaped on a long fleshy stem; disc white to pale crimson 2-4 cm. diameter; externally pale, slightly tomentose; spores 22-25 x 8-12 μ.

G. pallidus, Rod. Cup-shaped 5-8 mm. diameter on a slender stem of 10 mm., all parts white becoming brown when dry, thin fleshy externally smooth or slightly mealy; margin brownish with short irregular fimbriations; disc smooth, asci linear; spores oblong, hyaline, minutely verruculose; 22-24 x 10 μ.

On ground.

Sepultaria.

Ascophore large subterranean, globose and completely closed when young; emerging from the ground the apex is ruptured in a more or less stellate manner exposing the disc, fleshy, externally with numerous hyphæ extending from the surface through the soil; asci cylindric, 8-spored; spores obliquely uniseriate, hyaline, continuous, smooth, elliptic.

The genus appears more of the character of *Carnosæ.*

S. austrogeaster, Rod. Oblong, about 1 cm. diameter on emerging splitting into few bold lobes and resembling in appearance the outer peridium of *Geaster;* fleshy, dull-brown, clothed with copious earth-binding hyphæ; spores broadly elliptic, very obtuse, hyaline, smooth, 24 x 10 μ., paraphyses clavate with a thickened end septate the sections often swollen and moniliform.

In the mature state very like *Peziza cochleata.*

S. aurantia, Rod. Habit of the genus but only about 6 mm. diameter; disc bright orange to yellow or ochre; spores elliptic, rather acute at both ends, hyaline, smooth, 22 x 8 μ.; paraphyses filiform, septate, hyaline.

Section III.—Carnosæ.

Spores globose.

Barlæa. Spores hyaline.

Curreyella. Spores coloured.

Spores elliptic or fusiform.

Spores hyaline.

Humaria. Small, on ground.

Peziza. Large cup-shaped.
Otidea. Split on one side or contorted.
Rhizina. Flat and bound to the substratum.
Aleurina. Spores dark.

Aberrant members of the section.
Urnula. Cup-shaped, black.
Hydnocystis. Convoluted, white.

Barlæa.

Ascophore small, fleshy, sessile, concave to plane glabrous, cortex parenchymatous; asci cylindric, 8-spored; spores globose, hyaline.

Growing on the ground.

Saccardo places *Barlæa* and *Curreyella* in *Detonia.*

B. miltina, Berk. Peltate, soft-fleshy deep crimson-red to orange-red, 4-10 mm. diameter, disc smooth shining; externally paler, obscurely furfuraceous; asci cylindric; spores smooth, 12-16 μ.; paraphyses filiform.

B. verrucosa, Rod. Sessile, peltate, fleshy, 1 mm. diameter, crimson, externally paler; spores 20 μ.; covered with large hemispheric warts; paraphyses slender, apex clavate crimson.

Probably not distinct from *Lamprospora tuberculata, Seaver.*

B. miniata, Sacc. Sessile, cup-shaped waxy, 1-2 mm. diameter, disc crimson, exciple extending beyond the disc, often forming a dentate ochraceous collar; external surface glabrous; spores 13-18 μ., smooth when young alveolate when mature; paraphyses filiform curved at the end.

B. archeri, Berk. Sessile, concavo-convex, fleshy crimson, 2-3 mm. diameter, exciple not extending beyond the disc; spores hyaline, smooth, 6-12 μ.; paraphyses filiform. Very close to *B. miniata.*

B. echinulata, n.s. Sessile, discoid with an obtuse margin, disc crimson, 2-4 mm. diameter, external surface and margin ochraceous, exciple ochre and extending in teeth beyond the disc; spores hyaline, echinulate, 20-22 μ.

Curreyella.

Ascophore sessile or very shortly stalked, fleshy rather large, widely expanding; exciple parenchymatous; asci cylindric, 8-spored, spores globose, uniseriate, coloured at maturity; paraphyses septate, clavate.

C. trachycarpa, Mass. Ascophore shortly stalked, plane but undulate when mature often contorted, 1-6 cm. diameter; disc chestnut brown or variously darkened, externally granular; spores globose and for a long time hyaline and smooth, finally pale brown and closely covered with blunt warts, 10-14 μ.

C. alveolata, n.s. Sessile, plane to convex, rather tough, 1-2 cm. diameter, externally verrucose; spores globose, light brown, alveolate, 24 μ., paraphyses slender filiform, not enlarged at the apex.

Humaria.

Ascophore sessile, fleshy, at first closed then plane; glabrous, cortical cells polygonal; asci cylindric, 8-spored, spores uniseriate, continuous, hyaline, elliptic.

On the ground; not on wood.

Disc brown.

macrospora, spores verrucose.
tenacella, spores smooth.
bovina, fimicole.

Disc red or yellow.

muelleri, disc plane.
carbonigena, disc umbilicate.
fusispora, spores fusiform.
rutilans, spores reticulate.
omphalodes, on a subicle.
candida, white.
granulata, fimicole.
mollispora, spores allantoid.
stipitata, stalked.

H. macrospora, Fckl. Peziza brunnea atra, Desm. Blackish-brown, 1-1.5 cm. diameter; spores hyaline, continuous, elliptic, acute, verrucose when mature, 20-22 x 10 μ.; paraphyses septate, apex enlarged brown.

H. tenacella, Phil. Disc brown umber, 3-6 mm. diameter, margin entire often repand; spores elliptic, hyaline, smooth, 10 x 6 μ.; paraphyses slender with thickened brown curved apex.

H. bovina, Sacc. Brown umber, glabrous; disc umbilicate, undulate, about 1 cm. diameter; cortical cells very large; spores oblong-elliptic, hyaline, smooth, 19 x 9, paraphyses few or none.

On cow dung.

H. muelleri, Berk. Sessile, plane, fleshy, 1 mm. diameter, crimson, externally paler. slightly pilose, margin prominent, obtuse, spores hyaline, smooth, elliptic, 18 x 9 μ.; paraphyses clavate at the apex.

H. carbonigena, Berk. Sessile, flexuose and umbilicate, dark red, margin brown acute, 2-3 mm. diameter, disc granular, spores elliptic, smooth, 22 x 12 μ., paraphyses clavate at apex.

H. fusispora, Berk. Sessile concave to plane, yellow, 2-5 mm.; spores fusiform acute, 30-32 μ.; paraphyses clavate and crimson at the apex.

H. rutilans, Sacc. Ascophore attached by a minute central point, disc concave plane, margin entire obtuse, parenchymatous orange to crimson, 3-10 mm. diameter, paler externally and minutely downy; spores obtuse, smooth, then minutely reticulate, 13-15 x 8-9 μ.; paraphyses slender septate with an orange clavate apex.

H. omphalodes, Mass. *Pyronema omphalodes, Sacc.* Sessile and crowded into crust-like expansions seated on a white tomentose subiculum, plane to convex, orange to red, 1 mm. diameter, spores hyaline, smooth, elliptic, obtuse, 11-13 x 6 μ.

H. candida, n.s. On the ground, hemispheric, waxy, dull white; 2-6 mm., disc concave, externally minutely tomentose, asci cylindric, apex flat; spores smooth, hyaline, elliptic, 12 x 6 μ.

H. granulata, Sacc. Sessile plane soft; disc deep orange to red, 1-3 mm. diameter, externally paler and granulose; spores elliptic, hyaline, 15-20 x 8-9 μ.; paraphyses very short, broadly clavate, septate, red.

On horse and cow dung.

H. mollispora, Rod. Hemispheric, fleshy, pinkish, hyaline, exciple smooth, disc plane; spores elliptic fusiform, smooth, allantoid, the wall very thin, 18-5 μ.

On the ground amongst small moss.

H. stipitata, n.s. Plane often undulate, dark orange, fleshy, 4-6 mm. diameter on a short stem, externally little paler, subpruinose; asci cylindric; spores elliptic, hyaline, smooth, 10 x 5 μ., paraphyses filiform.

Differing from *Ombrophila aurantiaca* in being fleshy not cartilaginous, and from *Helotium citrinum* by growing on the ground.

Peziza.

Ascophore sessile, or with a short stem-like base; fleshy and brittle, cup-shaped, rarely plane, externally mealy to somewhat verrucose, cortical cells polygonal; asci cylindric, 8-spored; spores uniseriate, continuous, hyaline, elliptic, smooth or rough; paraphyses present.

Growing on the ground, differing from *Humaria* by the larger size and mealy or rough exterior.

Spores smooth.

cochleata, umber, spores 17 x 7 μ.
vesciculosa, dark umber, spores 22 x 11 μ.
repanda, dark chestnut, spores 20 x 10.
plicata, cinnamon, margin crenate.
drummondi, dark brown, margin plain.
convoluta, dark brown, convoluted.

Spores rough.

badia, spores obtuse, brownish-ochre.
aurantia, bright crimson.

P. cochleata, Bull. Cup-shaped, but usually much split and contorted; disc pale smoky umber throughout, fleshy, 5-8 cm. diameter; externally paler, slightly pruinose; exciple spongy and cavernous, spores hyaline, continuous, smooth, 16-18 x 7-8 μ.

On ground.

P. vesciculosa, Bull. Clustered and distorted, cup-shaped, disc rather dark brown, externally granular paler, spores smooth, hyaline, continuous, elliptic, obtuse, 21-24 x 11-12 μ.

Common on rotting manure.

P. repanda, Wahl. Discina repanda, Fries. Sub-sessile, very flat, plane when mature, disc generally dark brown, sometimes paler, margin readily splitting, undulate often crenate, 4-10 cm. diameter; externally usually whitish and minutely granular; spores smooth, hyaline, continuous, elliptic, obtuse to acute; 18-22 x 11-12 μ.

P. convoluta, n.s. Disc umber brown, plane or reflexed, thrown into numerous bold veins or convolutions, margin lobed 3-4 cm., the young state concave and simpler; spores smooth, hyaline, elliptic, obtuse, 14-15 x 7 μ., externally not paler, smooth but thrown into numerous radiating obtuse and branched veins.

P. plicata, Mass et Rod. Sessile, plano-convex, softly fleshy, cinnamon-brown, about 1 cm. diameter, margin crenated and lobed, externally nearly white granular, spores elliptic, hyaline, smooth, 11 x 5 μ.

P. drummondi, Berk. Sessile, plane to recurved and contorted, margin usually entire, 1-2 cm. diameter, brown, externally paler and furfuraceous; spores elliptic, hyaline, smooth, obtuse, 14 x 6 μ.

P. badia, Pers. Large, cup-shaped, often 5 cm. broad, sessile or nearly so, fleshy and brittle, disc dark brown umber; externally paler and minutely granular, spores hyaline, continuous, elliptic, asperate when mature, 15-19 x 9-10 μ.

Distinguished from *P. cochleata* by the darker disc and rough spores.

P. aurantia, Pers. Large, often exceeding 5 cm., cup-shaped, fleshy brittle, usually much split, crimson-orange; externally pale; delicately pruinose, spores broadly elliptic, hyaline, continuous when mature with a deeply reticulate surface, 15-16 x 7-8 μ.

Massee places amongst others this and *P. cochleata* in the genus *Otidea.*

Forma stipitata, smaller than the type, more scarlet than crimson, on a well-developed stem.

Otidea.

Ascophore shortly stipitate or sessile, medium to large size, fleshy or somewhat leathery, externally scurfy, villose or almost glabrous, elongated and cut down on one side, nearly or quite to the base making the ascophore oblique, often irregularly contorted; asci cylindric, apex rounded or somewhat truncate, 8-spored, spores obliquely uniseriate, hyaline, continuous, smooth or rough, elliptic.

O. tasmanica, n.s. Sessile, concave, then plane but when mature strongly recurved, about 1 cm. diameter, attachment marginal or nearly so, delicately fleshy, dull lilac colour, externally glabrous, spores oblong, obtuse, smooth, 12-16 x 5 μ.

O. lobata, n.s. Ascophore lobed and much contorted lemon-yellow, often many arising from a common stroma, attachment eccentric, 3-15 mm. diameter, externally glabrous; spores elliptic, smooth, hyaline, 16 x 5 μ.

Much like *Ombrophila aurantiaca,* but not cartilaginous, also *Phæopezia ochracea,* but the spores not coloured.

Aleurina.

Cupulate fleshy, sessile or shortly stalked medium size; externally lightly furfuraceous or glabrous; asci cylindric

8-spored; spores uniseriate, continuous, smooth or verrucose, coloured, pale sooty-brown.

Differing from smaller forms of *Peziza* only in the spores being coloured.

A. apiculata, Sacc. Ascophore sessile or shortly stalked concave to convex, rather tough, disc very dark brown, margin entire, externally nearly white; spores elliptic smooth, acute at both ends brown to black, 20-25 x 7-11 μ.

A. ochracea, Mass et Rod. Sessile or shortly stalked solitary or densely crowded often many cups arising from a common stroma, concavo-convex, dull orange, 6-12 mm. diameter; margin undulate, externally white, spores elliptic, acute at both ends smooth, light brown 15-18 x 6-7 μ.

Very like *Ombrophila aurantiaca* and *Otidea lobata* but differing by the coloured spores.

A. stipitata, n.s. Ascophore cup-shaped on a stem longer than the diameter of the disc, the whole plant chestnut brown, 4-8 mm. diameter usually cæspitose; externally smooth and shining stem relatively stout 8-10 mm.; spores smooth oblong at first hyaline, becoming dark grey to nearly black 12-16 x 4 μ.

May be referred to *Podaleuris.*

A. tasmanica, Mass. Sessile, cup-shaped, almost leathery, 1-2 cm. diameter, disc when young dark greenish brown, externally chestnut brown, verrucose, coarsely so on the margin, exciple parenchymatous, cell-walls brown; spores elliptic, dark brown, covered with coarse protuberances, 28 x 16 μ., paraphyses filiform, stiff, dark, with clavate or globose apex.

Rhizina.

Ascophore sessile, fleshy, expanded from the first, bound down by strands of copious mycelium leaving the margin alone free; asci cylindric, 8-spored, spores continuous or uniseptate, hyaline or brown smooth, elliptic or fusiform uniseriate.

R. lignicola, n.s. Ascophore black, expanded, plane but twisted and revolute, smooth, bound down by coarse strands, 2-4 cm. diameter; spores smooth, hyaline, or very faintly tinted, uniseptate, 9 x 3 μ.

Urnula campylospora = U. rhytidea, Berk. Ascophore large cup-shaped, black, stipitate, often several arising from a common stroma; fleshy, neither corky nor cartilaginous; asci very long, cylindric, 8-spored; spores smooth, dark, oblong, curved, 22-30 x 8-10 μ.

f. tenella. Smaller and the ascophore very thin and fragile.

Generally referred to *Dermatæ,* but though the common stroma and erumpent habit agree, yet the large size and fleshy substance do not.

Hydnocystis cyclospora, Mass. et Rod. 2-3 mm. diameter, white, fragile or fleshy, convoluted, hollow, the hymenium lining the inner surface, half-subterranean and emerging on maturity; asci cylindric; spores nearly spherical, 10 x 8, smooth, hyaline.

Hydnocystis echinospora, n.s. White, fragile, fleshy, 1 cm., convoluted, hollow, the hymenium lining the inner surface orifice near the base, emerging from the soil at maturity; asci cylindric, 8-spored; spores uniseptate, spores oblong, obtuse, 18 x 12 μ., echinulate, hyaline.

Originally described in error as *Sphærosoma tasmanica. Hydnocystis* connects the *Pezizas* with the *Tuberaceæ.*

Family HELVELLEÆ.

Ascophore clavate, capitate, pulvinate or otherwise disposed, but the ascigerous layer on the upper or external surface free from the first and not formed in a cup as in other members of the Order.

Helvella. Stem thick, ascophore folded.

Morchella. Stem thick, ascophore in pits and ridges.

Cyttaria. No stem, ascigerous layer in pits.

Leotia. Stem and ascophore mucilaginous.

Vibrissia. Ascophore a small simple head on a stem.

Geoglossum. Erect club. Spores filiform.

Mitrula. Erect club. Spores elliptic.

Spragueola. A minute sessile cushion.

Helvella.

Ascophore a thick fleshy convoluted body, generally 3-6 cm. diameter, on a thick fleshy stem 4-8 cm. long; hymenium spread over the upper surface; asci cylindric, 8-spored; spores hyaline, smooth, elliptic.

H. monachella, Fries. Ascophore purple black, stem hollow pale; spores 16-17 x 10 μ.

Edible.

Morchella.

Ascophore thick fleshy, the surface formed by ridges and pits over which the ascigerous layer is distributed.
Edible.

M. tasmanica, J. Ramsbottom. Ascophore pyramidal with a constricted base, surface raised into longitudinal ridges with small connecting lines between, blackish brown, 5-10 cm. tall, stem pale hollow, shorter than the head, spores 20 x 10 μ.

M. conica, Pers. Ascophore conical, acute, from a broad base, stem sometimes much exceeding the head.

Cyttaria.

Globose from a slender attaching point, about 2-3 cm., almost cartilaginous, apricot yellow, the upper half bearing numerous depressions in which the ascigerous layer forms, at first the pits are covered by a membrane, the lower portion of the body is sterile, spores ellipsoid, continuous.

Parasitic on *Notofagus cunninghami.*

C. gunnii, Hook. The character of the genus.

Leotia.

Ascophore stipitate, substance fleshy-gelatinous, convoluted into a round head, ascigerous layer covering the upper surface, stem relatively long; asci clavate, 8-spored; spores hyaline, continuous, or uniseptate, narrow, elliptical.

L. lubrica, Pers. Usually gregarious, mucilaginous, all over greenish yellow; head 1-2 cm. diameter, stem 2-8 cm. long; spores 22-25 x 5-6 μ.

Vibrissia.

Ascophore sessile or stipitate, head hemispheric, smooth, the ascigerous layer reflected over the outer surface, substance soft; asci clavate, narrowed below into a slender pedicel, 8-spored; spores filiform, hyaline, as long as the asci, in a fascicle, remaining fixed to the head and vibrating for some time after maturity.

V. tasmanica, n.s. Solitary or two or more arising from a common base, on dead twigs in the water or on wet ground; stem slender, glabrous, pale dull green, up to 1 cm. long; head hemispheric, 3-4 mm. diameter, umbilicate beneath for the insertion of the stem, pale dull green glabrous, asci narrow, cylindric, 180 x 3 μ., spores filiform 80-120 x 1 μ., about 10 septate.

Geoglossum.

Ascophore clavate, fleshy, the ascigerous layer reflected over the upper thickened portion of the club, erect, entire; asci clavate, 8-spored; spores linear arranged in a fascicle, brown, septate, stem short or elongated, surface black, internally white.

G. glabrum, Pers. G. nigritum, Fries. Black sometimes tinged with olive or purple, dry; fertile portion not sharply distinct, glabrous, cylindric or slightly flattened, 3-7 cm. long; stem glabrous; spores linear, 75-85 x 8-9 μ., brown, 7 septate, slightly constricted; paraphyses clavate above, many septate, the upper segments often moniliform.

G. australe, Berk. Black, 6-10 cm., fertile portion usually flat, short, glabrous; sometimes longer, stem long slender and with a squamulose surface; spores 80-120 μ. x 4-6 μ., 7 septate.

G. hirsutum, Pers. Black, dry, everywhere densely velvety, the bristles much exceeding the asci; fertile portion generally about 1 cm. from lanceolate, flattened to globose or otherwise irregular; stem usually long and slender; spores 120-160, light brown, 7-15 septate, paraphyses slender, septate with slightly thickened curved ends.

G. walteri, Berk. Differing from *G. hirsutum* by the shorter spores, 80-110, with 7 septa, and few bristles, which hardly exceed the asci.

G. farlowi, Cooke. Also similar to *G. hirsutum*, but the bristles still more reduced and the spores 60-75 μ. long and constantly 3 septate.

Mitrula.

Ascophore erect, clavate to globose on a long stalk, fleshy, variously coloured, often black, asci narrow, 8-spored; spores narrowly elliptic, uni-biseriate, hyaline, septate rarely continuous. Differing from *Geoglossum* only in the spores.

M. serpentina, Mass. Geoglossum viride, Pers. Usually cæspitose. yellowish-green to olive-green, turning black when dry, mostly 4 cm. long; ascigerous portion expanded, clavate rather flat, glabrous often slimy, hollow stem slender, granulose; spores hyaline, smooth, narrow, elliptic, ends rather acute, when old 3 septate, 13-18 x 5 μ.; paraphyses slender, septate, straight, apex clavate and tinged with green.

Forma carnea = M. carnea, Sch. Differs only in the colour, which is pale fleshy.

M. rufa, Sacc. Cæspitose, free or many from a common base, clavate, 4-5 cm., the whole plant glabrous or the stem slightly squamulose; dark smoky ochre, fertile portion distinct, flattened with obtuse edges; asci clavate, 8-spored, spores irregularly biseriate; spores fusiform, smooth, hyaline, curved, continuous when young becoming 2-5 septate; 28-32 x 5 μ.; paraphyses filiform branched, ends curved often in a complete circle.

M. berterii, Mont. M. vinosa, Berk. Blackish-brown with a tinge of purple, glabrous, fertile portion thin cylindric, about 1 cm.; stem similar or rather longer, only about 2 mm. thick; spores hyaline, continuous, smooth, 7-10 x 1.5-2 μ.; paraphyses slender, tips slightly clavate, tinged with red or brown.

M. cucullata, Fries. Gregarious, slender, seldom exceeding 1 cm., orange yellow to brown, sporiferous portion hollow, glabrous, ovate to nearly globose, generally compressed, 2-4 x 2 mm., stem slender, often crooked; spores hyaline, smooth, continuous, nearly fusiform, 12-18 x 3 μ.; paraphyses slender, tips clavate.

Spragueola.

Ascophore sessile, hemispheric, irregularly undulate surface, solid, hymenium covering the entirely exposed surface, attached to the substratum by radiating mycelium, substance almost mucilaginous; asci cylindric, 8-spored; spores uniseriate, continuous; in the type hyaline, smooth, elliptic, but in the Tasmanian species they are globose, echinulate; paraphyses slender, septate.

This definition is adapted from that of the genus by Geo. Massee in the *Annals of Botany,* vol. II., page 295. This course was preferred to that of establishing a new genus for its inclusion. It appears that Massee first used the name for a distorted *Mitrula, M. americana,* and subsequently transferred it. This may not have been strictly in accordance with rules, but has proved convenient.

S. mucida, Rod. Ascophore sessile, sub-globose, vaguely undulate, about 5 mm. diameter, on half-buried wood in damp places, white; spores globose, coarsely echinulate, 18 μ. diameter; paraphyses exceeding the asci filiform, attenuate at the apex immersed in dense jelly; at maturity the jelly increases and spreads to 1-2 cm. carrying paraphyses, asci, and spores with it.

Family GYMNOASCACEÆ.

No defined ascophore, the asci erect and packed in a single layer on the surface of the host or non-living material.

Ascomyces. Parasitic.

Ascomyces trochocarpæ, n.s. Enlarging and distorting the pistil of *Trochocarpa disticha.*

Ascomyces deformans. Covering the under surface of the leaf forming a light brown layer and causing much distortion (Peach curl).

Ascomyces aureus. Causing golden yellow blisters on leaves of Black Poplar.

Ascocorticium. No ascophore. Asci closely packed on a plane or irregular erect growth. Saprophytic.

Ascocorticium effusum, Rod. Bright scarlet, waxy, creeping over earth or wood, plane or with a nodular or irregular papillose surface; asci cylindric, 8 uniseriate spores; spores ellipsoid, smooth, hyaline, obtuse, 12-16 x 5-8 μ.; paraphyses filiform.

On ground; burnt wood; also on a plastered wall.

THE PENETRATING RADIATION IN THE ATMOSPHERE AT HOBART.

By A. L. McAulay and Miss N. L. Hutchison.

(With 6 Text Figures.)

(Read 1st December, 1924.)

GENERAL.

If a gas be enclosed in a thick-walled vessel and protected from all external disurbances a few of its atoms are still found to be ionised during every second. It can be shown that this residual ionisation cannot be due to the heat energy of the gas itself (1), the atoms must therefore be broken up by a radiation coming from without. This external radiation must arise in the walls of the vessel itself, or penetrate them. If the former is the case we may say with fair certainty that it is due to radio-active matter in the walls, and if the latter it must be a radiation of extremely great penetrating power, as shielding the vessel with several feet of water has little effect on the ionisation. The residual ionisation is now known to be due to both these causes, and they may be distinguished from one another experimentally. The origin of at any rate a part of the radiation is still in doubt, and measurements made at different parts of the earth's surface may be expected to provide evidence indicating what factors are concerned.

Recent experiments by various workers have given curiously contradictory indications as to the nature of the penetrating radiation, leaving the matter in a condition most stimulating for further research.

Millikan (2) and others (3, 4, 5) have shown that the radiation increases in intensity with the height above sea level at which the measurement is made, and, further, that it varies with meteorological conditions (6). This would seem to show decisively that it is an external radiation, and that it probably arises in the upper atmosphere.

But at a depth of six metres under water it shows little or no trace of absorption (7). Also Downey (8) and Fruth (9) have shown that in a sphere of radius 12 inches at a pressure of approximately 47 atmospheres the ionisation no longer increases with pressure, but remains constant. These facts suggest that there is no penetrating radiation coming from without, but that everything is due to the walls of the vessel containing the gas. Experiments such as those of Millikan necessitate some other explanation, however. The most hopeful appears to be that an extremely penetrating external radiation of the γ type ejects high-speed electrons from the walls of the vessel, which in turn produce the observed ionisation.

If this explanation is the correct one we are brought to the interesting conclusion that the penetrating radiation is very different from any other γ radiation of which we know. In the first place the great range of the ejected electrons shows that its frequency must be greater than at any rate most of the γ rays from radium B and C. This suggestion is borne out by its great penetrating power. Secondly, if it were of ordinary γ ray type a rough calculation shows that at 47 atmospheres as many high-speed electrons should be ejected from the gas as from the walls of the vessel, and consequently the ionisation should still increase with pressure. Perhaps it is best to attempt to explain Downey's and Fruth's results by supposing a change in the molecular constitution of gases at this pressure. Certain of Fruth's results appear to lend colour to this view.

Recent experiments show clearly that the intensity of the penetrating radiation varies with time. There is certainly a daily variation and probably a seasonal variation as well (10). The maximum intensity of the penetrating radiation does not occur at different places at the same local time.

In view of the fact that there are indications that the atmospheric potential gradient exhibits a diurnal variation whose maximum occurs at different places at the same Greenwich time and not at the same local time, considerable interest attaches to the problem of determining the time at which the maximum intensity of the penetrating radiation occurs at different places on the earth's surface.

OBJECTS OF RESEARCH AND GENERAL EXPERIMENTAL METHOD.

The present paper describes the results of a set of measurements made to determine the intensity of the penetrating radiation in Hobart, and to investigate its diurnal variation.

The investigation was commenced under the direction of one of us by Mr. R. W. Crabtree earlier in this year, but before the construction of the apparatus was complete he left to take up the position of Demonstrator in Natural Philosophy in the University of Melbourne.

It is hoped later to investigate the variation of the intensity of the radiation with altitude, and to make further experiments on its variation with time.

The method used is similar to one employed by Dr. K. M. Downey (10), but our apparatus is less refined. The ionisation is produced in a cast-iron sphere, A., fig. 1, 20 cms. in internal diameter, with walls 1½ cms. thick. An electrode consisting of a small sphere, C., of 3.5 cms. diameter, soldered to the end of a stout wire, is held inside the

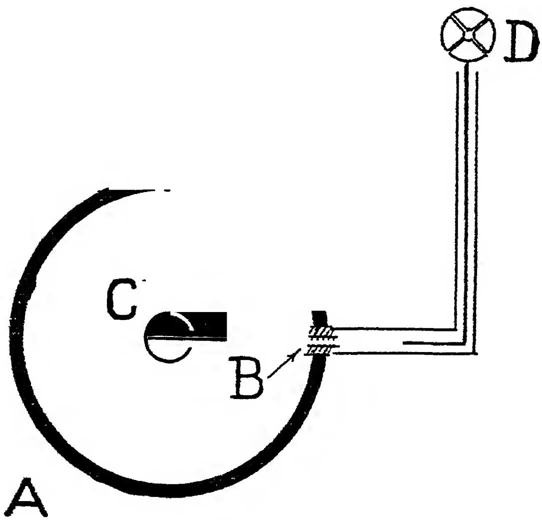


Figure I

sphere by a sulphur plug B. This serves to collect the ions produced within A. by the penetrating radiation and other causes. The rate of production of ions so collected is measured by the motion of the needle of a Compton quadrant electrometer D.

The effect of the penetrating radiation itself is estimated by observing the change in the speed with which the electrometer charges when gas at different pressures is contained in A.

More than 19-20ths of the radiation due to radio-active matter in the walls of the sphere is completely absorbed by the gas in the sphere at atmospheric pressure, and consequently the ionisation due to it does not change sensibly with increasing pressure. On the other hand, the effect of the penetrating radiation for the relatively low pressures we have used is proportional to the pressure. The two effects can therefore be distinguished by such experiments.

EXPERIMENTAL PROCEDURE.

The earlier experiments made had for their object the determination of the average intensity of the penetrating radiation in Hobart. They will not be discussed, as the later work on the diurnal variation has superseded them. The earlier experiments were consistent with the later ones, but were not made under the same standard conditions.

Under the rather bad experimental conditions in which this work has been carried out it has not been found possible to maintain the pressure constant in the sphere (A. fig. 1.) in which the ionisation is measured. The sphere is filled with oxygen to a pressure of 50 to 60 lb. per sq. in. above atmospheric, and observations are made while it decreases owing to leakage. In these circumstances the accurate determination of the effect of the soft radiation from the walls of the sphere is of the first importance in making a determination of the variation of the penetrating radiation with time, as well as in its absolute measurement.

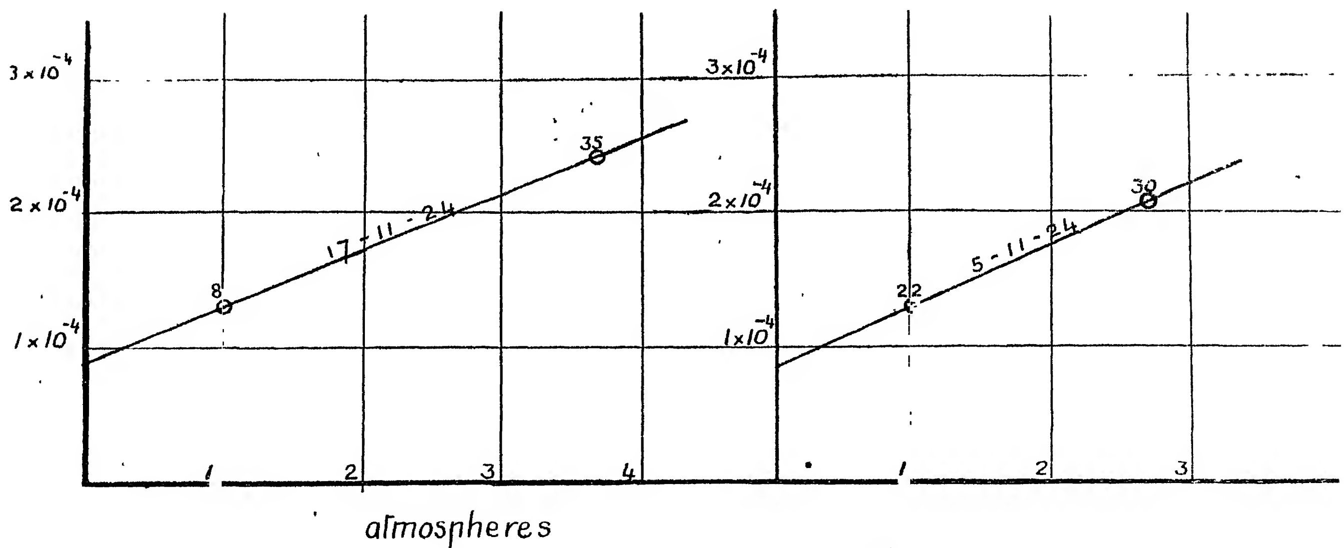
There is no effect due to emanation, as the gas used is oxygen from a cylinder in which it has stood for more than a month.

Ionisation due to Soft Radiation.—To determine the ionisation due to the soft radiation it is necessary to measure the total ionisation when the pressure in the sphere is as high as possible, and when it is atmospheric, while the penetrating radiation must remain sensibly constant during an experiment.

The ionisations are plotted as ordinates against the pressures as abscissæ. The slope of the straight line joining the points then gives the ionisation due to the penetrating radiation per unit increase in pressure, while the ordinate at zero pressure gives the effect due to the soft radiation. The assumption is here made that the curve connecting ionisation and pressure is a straight line for the low pressures we have used. This has been found by Downey and others, and has been roughly verified by our earlier experiments.

Fig. 2 shows two curves obtained as indicated on two different days. Ionisation is given in volts fall per second of the electrode system, and the pressure is given in atmospheres with zero at vacuo. The figures above the points give the minutes occupied by the observations. The soft radiation as deduced from the two curves is the same within the limits of experimental error. Curve B has twice the weight of A., and the resulting value of the ionisation due to the soft radiation is $.87 \times 10^{-4}$ in the arbitrary units used. Less direct methods show that this is certainly not far from the truth.

Experiment on Diurnal Variation.—The following experiment is made to determine the diurnal variation of the penetrating radiation. Oxygen is admitted to the sphere and left for an hour. The electrode system is charged, the voltage sensitivity of the electrometer measured, the electrode is isolated, and an observation made of the time taken for the system to charge 2, 3, or 4 fiftieths of a volt, according to circumstances. The electrode system is then recharged, and the observation repeated until the pressure falls to about 20 lb. per sq. in. above atmospheric, when oxygen is again admitted. From the determination of the ionisation so made the constant ionisation due to the soft radiation is subtracted and the result divided by the pressure in atmospheres measured from vacuo. This is the ionisation due to the penetrating radiation per atmosphere. The curves of Fig. 3 show this quantity plotted against time on various days.



3 x 10⁻⁴
2 x 10⁻⁴
1 x 10⁻⁴
8
17 - 11 - 24
35
1
2
3
4
3x10⁻⁴
2x10⁻⁴
1x10⁻⁴
22
5 - 11 - 24
30
1
2
3
atmospheres

Figure II

Saturation and Insulation Leakage.—It was found that 120 volts between the sphere and the electrode gave a field amply strong enough to saturate the gas at the pressures used, and 160 volts were used in the experiments. The electrode system was insulated by sulphur and quartz, and everywhere surrounded by earthed conductors and guard-rings. When measuring the current the precaution was always taken of allowing the electrode to charge to as high a potential on one side of earth as it fell from on the other side of earth, and in this way any leakage across the insulation was eliminated. As a matter of fact, such leakage was found to be absolutely negligible.

RESULTS.

Fig. 3 shows typical curves obtained, as explained in the last section, in which the ionisation produced by the penetrating radiation alone per atmosphere of pressure is plotted against time. A and B run consecutively, and represent an experiment lasting twenty-eight hours. The blanks mark the times at which oxygen was re-admitted to the sphere, and the subsequent hour intervals that were found to be needed before conditions had once more become steady. C. fig. 3 is another similar curve, comprising ten hours' observations, and showing a different type of variation.

Absolute Value of the Ionisation Produced by the Penetrating Radiation.—It will be seen from the curves that the effect is subject to large fluctuations. The lowest value we observed for any length of time was about $1\frac{1}{3}$ ions per c.c. per second averaged over two hours. The highest value observed was about $3\frac{1}{2}$ ions per c.c. per second averaged over five hours.

To convert the arbitrary ordinates of the curves of Figs. 2 and 3 into pairs of ions per c.c. per second produced by the penetrating radiation in oxygen at atmospheric pressure they must be multiplied by 6.8×10^4. Thus the average value for the twenty-four hours beginning at noon on 13.11.24 was about 3 ions per c.c. per second.

It was found difficult to obtain consistent experimental values for the capacity of the apparatus; however, the mean of those obtained experimentally by the best methods used was fairly close to that calculated. It is perhaps pos-

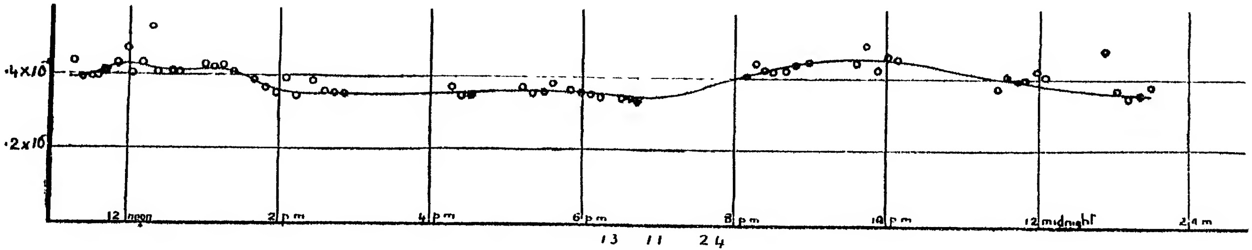


Figure III A

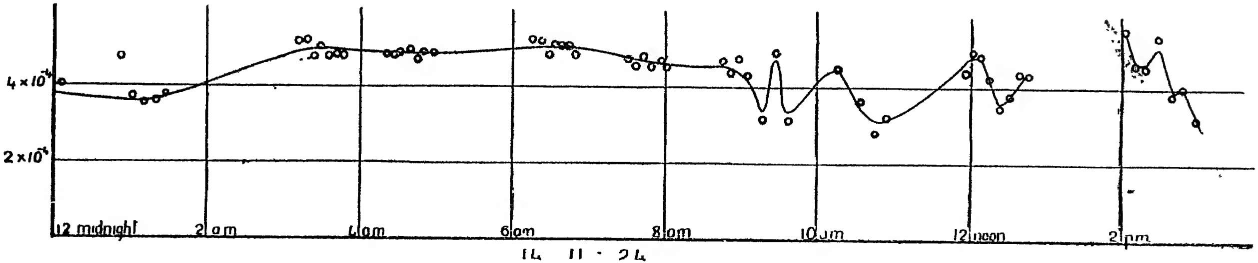


Figure III B

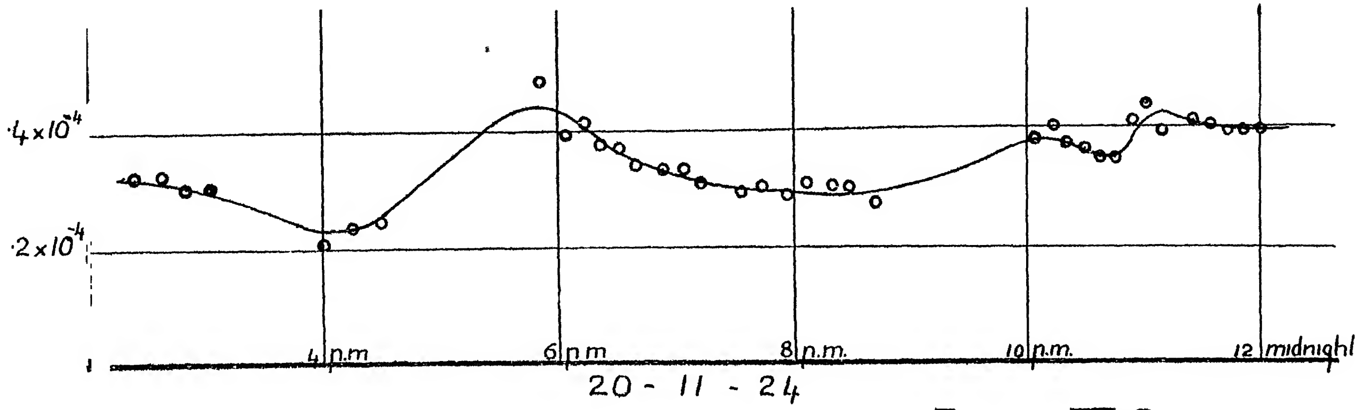


Figure III C

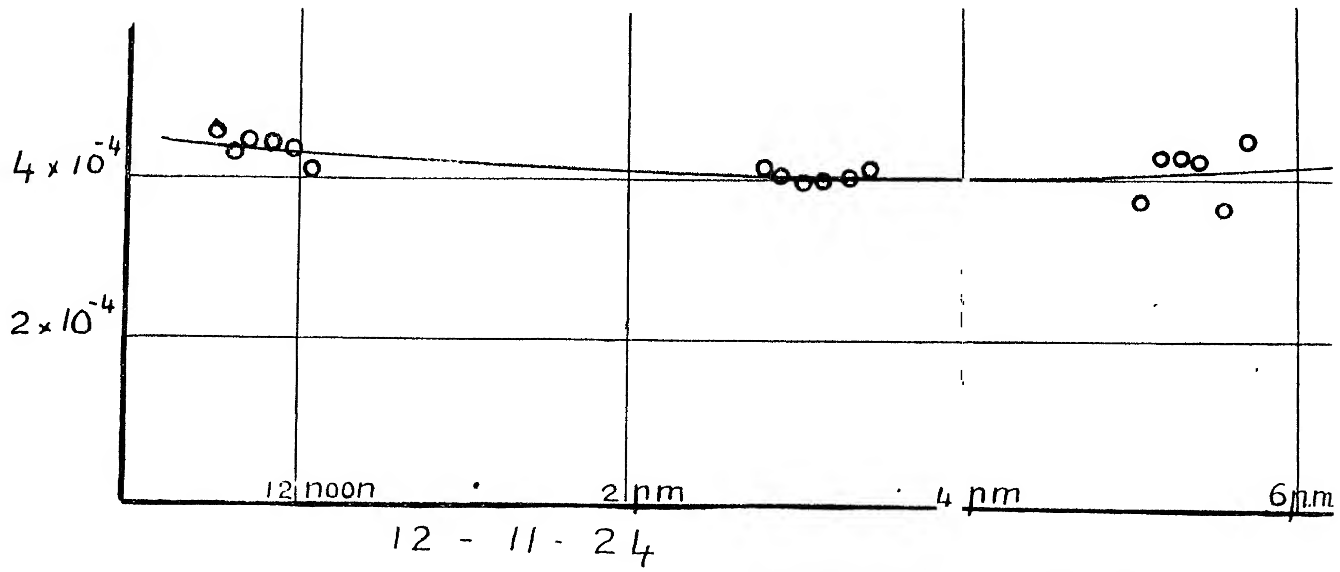


Figure III D

sible, though improbable, that the constant given above is 20 per cent. in error. It was not possible to use the method of observing the leak produced by a standard source of gamma rays, as we had no radium or thorium at our disposal.

Soft Radiation.—The points plotted on curves A and B each represent a four or five minutes' observation; those on curve C one of six or seven minutes. They will vary about the mean on account of the probability variations in the number of alpha particles leaving the walls of the sphere per second. The amount of the soft radiation shows that not more than 12 alpha particles traverse the sphere in a minute (assuming that each produces 1.2×10^5 ions in its course), so that the probability variations will be large, especially for low pressures. It is of interest to note that the effect of the penetrating radiation at one atmosphere is less than that of 6 alpha particles per minute traversing the whole sphere.

Diurnal Variation.—A general analysis of our results seems to suggest a diurnal variation of regular type, on which is superposed large and rapid fluctuations of a more irregular nature. There appears also to be very considerable variation of the effect over a longer period.

The most extreme case of the irregular rapid variation which we have observed is seen starting with great suddenness at about 9 a.m. on 14.11.24, after a very steady 24 hours. For the week prior to 13.11.24 conditions had been very steady, and the rapid fluctuations of the 14th were at first attributed to some experimental fault that had suddenly developed, but none that could explain the fluctuations was found. During the week following the 14th the variation of the penetrating radiation was similar to that of the 14th, though not quite so erratic. On the whole, the value was considerably lower than for the preceding week.

In general we find from our short term of experimenting that the effect tends to be low and variable on hot, cloudless days, and higher and steady during colder southerly weather. We also find that the effect is higher during the night than during the day, the principal maximum occurring at 5 a.m., and the minimum at 5 p.m. These maxima and minima are liable to be masked by what we are considering as superimposed fluctuations, and on one day in particular we

observed a local maximum of about 3.8 in the arbitrary units used in the graphs at 4.30 p.m., while at 10 p.m. the effect was as low as 2.0. Unfortunately that day's observations ended at that point.

The times at which our maxima appear do not correspond with those given by other workers. The local time of our principal maximum is nearly 12 hours different from the local time of the maximum found at Manilla (11), while as our longitude is only about 30 degrees different we disagree in Greenwich as well as in local time. The time of our maximum disagrees with that given by Downey (10), both according to local time and to Greenwich time.

It is stated (11) that in Kohlberg the penetrating radiation is greatest in the day and least at night. This is the opposite of what we have found.

Before speculating as to the reasons for these differences further experiments must be made to discover whether our diurnal maximum always occurs at the same time.

Causes of the Effect.—The principal probable sources of the penetrating radiation will now very briefly be considered from the point of view of our results.

(1) Gamma rays from the soil. The radiation due to this cause would, of course, be constant. It might be expected to produce 4 or 5 ions per c.c. per second if it were not cut off. Our observations have been made over a concrete floor. Downey (10) found that the effect over concrete was the same as that over water, which would indicate that the radiation from the soil was completely cut off. In view of the low value we have found for the effect and of the large fluctuations, there seems good reason to believe the same is the case in our observations. The walls of the laboratory are of brick.

(2) Radio-active deposit precipitated from the atmosphere on the roof. This effect might be expected to be marked in our experiments. The roof of the laboratory is about 15 feet above the sphere, and is of galvanised iron, lined only with thin pine boarding. King (13) estimates the radiation due to this cause to produce 1 to 2 ions per c.c. per second. The effect would, of course, vary with meteorological conditions. Such fluctuations as those shown at the right of curve B cannot, however, be due to this

cause. It is conceivable that there might be temporary rapid depositions, giving rise to sudden increases in the ionisation, but this ionisation must decrease at a slower rate, as even if the supply of active deposit is not replenished its hard gamma rays cannot fall to half value in less than half an hour.

(3) Other causes. The contribution of the gamma radiation from the emanation in the air is negligible. Further experiment is necessary before we are in a position to speculate as to the nature of the remainder of the radiation.

Our intention is next to attempt to eliminate the effect of the active deposit on the roof.

In conclusion, we wish to thank Dr. L. A. Bauer, of the Carnegie Institute, who very kindly presented us with literature on this subject.

REFERENCES.

(1) Kunsman, Phys. Rev., October, 1920.

(2) Millikan and Bowen, Proc. Amer. Phys. Soc., May, 1923.

(3) Otis, Proc. Amer. Phys. Soc., May, 1923.

(4) Otis, Proc. Amer. Phys. Soc., May, 1923.

(5) Kolhörster, Deutsch. Phys. Gesell., Verh., July, 1914

(6) Millikan and Otis, Proc. Amer. Phys. Soc., April, 1924.

(7) Gockel, Phys. Zeits., June, 1920.

(8) Downey, Phys. Rev., August, 1922.

(9) Fruth, Phys. Dev., August, 1923.

(10) Downey, Phys. Rev., November, 1920.

(11) Lassale, Phys. Rev., February, 1915.

(12) Kahler, Phys. Zeits., June, 1920.

(13) King, Phil. Mag., October, 1913.

NOTES ON THE HABITS OF THE EXTINCT TASMANIAN RACE.

(1) THE USES AND MANUFACTURE OF BONE IMPLEMENTS.

By W. L. Crowther, D.S.O., M.B.

Plates XX. and XXI.

(Read 1st December, 1924.)

INTRODUCTION.

For many years amongst those interested in the study of Tasmanian implements, existed the idea of certain bones having been used by the natives, probably as "scrapers."

Dr. F. Noetling (1) has examined certain specimens in the Tasmanian Museum, and in addition other bones excavated by himself at Rocky Cape. As a result, in the paper mentioned, he comes to the conclusion that those examples are simply portions of the fibulæ of *M. billardièri* fractured by falls of that animal in the course of its flight when pursued.

He reasons that all these specimens found in native feeding grounds are only traumatic fractures, and that therefore the use of bone implements was unknown to the native Tasmanian.

In much time spent in reading works that contain references to Tasmanian aborigines, I have found no instances of an observer seeing such implements in actual use.

Ling Roth (2) quotes La Billardière (3) as noting the natives prepare small spatulate pieces of wood, by which they separated limpets or sea ears from the rocks, on which to feast. These they smoothed with a piece of shell.

The bone implements 1, 2, 3, and 4, hereunder described in detail, would have been too light for such use, except in the case of small and not too adhesive shell fish. I cannot but feel, however, that they would have been of considerable use in extracting the contents of such edible types as *Turbo*, etc.

It seems reasonable to think, therefore, that such an instrument would be used, as a considerable proportion of the shells found on the mounds are unbroken, and those not intact do not seem to have been crushed between stones. Such implements may also have been of use in getting out the contents of oysters, mutton fish, and more particularly the small conical type of shells. It is to be remembered that although many settlers in Van Diemen's Land have seen the aborigines hunting and camping for a day or two on their migrations, very few indeed, except La Billardière, can have seen them in their natural state, collecting and eating their shell fish around their fires. The very presence of such observers would tend to cause all such feasting to cease.

DETAILED DESCRIPTION OF THE SPECIMENS.

The details of the specimens are as follows:—

No. 1.—Proximal Extremity of the *R. fibula* (*Macropus ruficollis*).

168 mm. in length. the epiphysis is wanting.

The specimen has been broken about the commencement of the middle third, where the shaft commences to flatten and comes into close relation to the Tibia. It presents a chisel-shaped edge. This edge, 5 mm. in length, has one serration, otherwise is smooth, and is not perfectly horizontal.

The mesial and lateral surfaces slope regularly to form this extremity.

The mesial surface, i.e., the relation to the Tibia, shows many fine longitudinal scratches, which may well have been incurred as a result of usage.

The lateral surface shows no marked features, except a few minute scratches. due perhaps, to friction.

With the exception of the hammer or pounding stones (4), it is established that the Tasmanians never ground their stone implements. Any shaping that may have been artificially induced in this bone specimen would probably have been by friction due to the use of its edge in extracting the bodies of the shell fish from the hard shell, prising open small bivalves and actions of such kind.

No. 2.—Proximal Extremity of *L. fibula* (*Macropus billardièri*).

165 mm. in length. Shows edge markedly oval in shape with an interesting flattening of the mesial surface, which has almost obliterated the irregularities of the origonal fracture. Very smooth to the touch. The longitudinal serrations noted in the previous specimen are not present.

The lateral surface shows a groove—probably artificial. Decidedly a lighter and more delicate instrument than Nos. 1 and 3.

No. 3.—Central portion of shaft of *L. fibula* (*Macropus giganteus*).

152 mm. in length. This specimen seems to me even more than 1 and 2 to have been definitely shaped for use. Its extremity is beautifully oval in shape, and particularly on the mesial surface shows for 14 mm. undoubted smoothing by friction.

The lateral surface shows longitudinal friction markings at the point where the ridge becomes continuous with the flatter area. At the actual edge a chip has broken from the surface.

The other fractured extremity shows no smoothing of its fracture surface, which is still quite sharp, jagged, and well defined—in decided contrast to the well-marked flattening and smoothing of the distal extremity.

No. 4.—Proximal Extremity of *R. fibula* (*Macropus billardièri*).

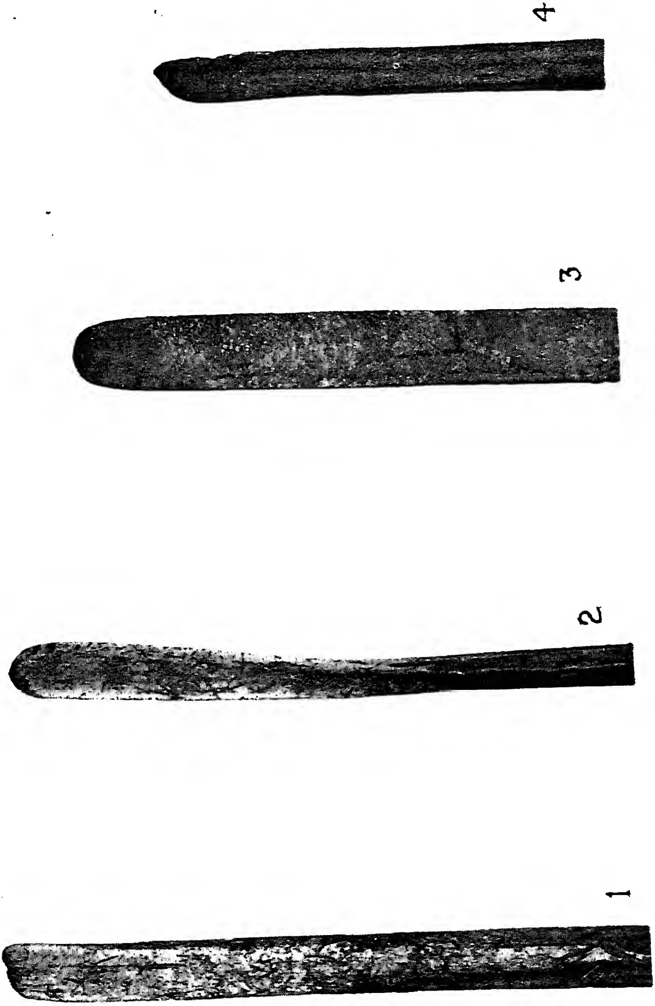
141 mm. I have included this specimen, as, although its edge approaches the wedge-shape, and shows rounding of the surface, it appears to me that such is very probably due to a limited amount of friction, either by man or the shifting of sand and shells in the Middens.

In any case, it approximates to the condition of the fractured ends of many bone fragments found among the remains of aboriginal shell mounds, and occupies a mid position between the well-smoothed edges of 1, 2, and 3, and the jagged fracture edge of No. 3.

The Tasmanian Museum has seven bone fragments labelled as implements.

1 2 3 4

Tasmanian Bone Implements.



Tasmanian Bone Implements.

One, A 2777, has a very well-rounded spatulate extremity, and resembles my specimen No. 2 very closely.

A 4305 may be classed as probably shaped by the aborigines. The others vary from splinters of long bones, to fibulæ such as I have described, except that their fracture edge shows no smoothing, and is such as would have been produced by ordinary traumatic fracture.

CONCLUSION.

To sum up, I feel that Dr. Noetling in the article described has dismissed in altogether too summarily a fashion the possibility of the use of these instruments. Just as a close study of the Tasmanian stone implements shows great variation in their workmanship with specialisation in the edges for different uses, so we may conclude that an individual who would go to such lengths in fashioning his stone work would experiment on and use such bone tools as Nos. 1, 2, and 3, and possibly 4.

I feel that ordinary fractures of these fibulæ would not give a surface such as I have described, and I conclude therefore that the four specimens described in detail have been deliberately shaped and used by the Tasmanians in connection with their routine feeding and daily life.

The actual discovery of such an implement in a small heap of shells and isolated from any other bony remains may possibly be made, and would be conclusive proof of their use as surmised.

REFERENCES.

(1) Pap. and Proc. Royal Society of Tas. 1911, p. 102.

(2) Ling Roth. "Aborigines of Tas.," 2nd Ed.

(3) La Billardière. "Voyage in search of La Pérouse."

(4) Dr. F. Noetling. "Tas. Naturalist," part 3.

THE ROYAL SOCIETY OF TASMANIA

ABSTRACT OF PROCEEDINGS

1924

7th March, 1924.

Annual Meeting.

The Annual Meeting was held on the 7th March at the Society's Rooms, Tasmanian Museum, Hobart, Mr. L. Rodway, C.M.G., Vice-President, presiding. The Annual Report and Statement of Accounts were read and adopted.

The following were elected members of the Council for 1924:—The Right Rev. Dr. R. S. Hay, Drs. W. L. Crowther and Gregory Sprott, Major L. F. Giblin, Messrs. W. H. Clemes, W. H. Cummins, J. A. Johnson, L. Rodway, and J. Moore-Robinson.

The Chairman extended a welcome to His Excellency Sir Francis Newdegate, K.C.M.G., Governor of Western Australia and ex-President of the Society. In reply His Excellency stated that he was very pleased to again visit Tasmania and meet many of his old friends.

The following were elected members of the Society:—Dr. W. W. Giblin, Messrs. G. B. Davies, Henry Oliver, C. Stephens, and Mrs. J. Kennedy.

Illustrated Lecture.

Mr. L. Rodway delivered an illustrated lecture on the Cradle Mountain-Lake St. Clair Scenic Reserve.

Conversazione.

At the conclusion of the meeting a Conversazione was held in the Art Gallery.

14th April, 1924.

The Monthly Meeting was held at the Society's Rooms on the 14th April, Mr. L. Rodway, C.M.G., presiding.

The following were elected members of the Society:—Messrs. E. A. Budge, J. W. Crabtree, Ronald Lord, James Marsh, H. Gray, F. M. Young, and Mrs. J. F. Hawker.

Papers.

The following papers were read:—

1. Two Interesting Fungi. By L. Rodway, C.M.G.
2. Ear Bones of *Nototheria* and Other Animals. By H. H. Scott and Clive Lord.
3. Notes on a Geological Reconnaissance of the Mount La Pérouse Range. By A. N. Lewis, M.C., LL.B.
4. Researches in Relativity. I. Criticism and Modification of Einstein's Latest Manifold. By Professor A. McAulay, M.A.

Illustrated Lecture.

Mr. A. N. Lewis delivered an illustrated lecture on "Ice, "the Controlling Factor in Tasmanian Economic Geography."

12th May, 1924.

A Special Meeting was held at the Society's Rooms on Monday, 12th May, Mr. L. Rodway, C.M.G., presiding.

Dr. W. L. Crowther moved that to Rule 22 be added the following words:—"In addition the Secretary shall also be a "member of the Council *ex officio*." In moving the resolution Dr. Crowther stated that the object was two-fold; first to make it easy to obtain a quorum at meetings of the Council; and, secondly, as a mark of appreciation of Mr. Lord's work on behalf of the Society and his work at the Tasmanian Museum. Seconded by Mr. Moore-Robinson and carried.

Mr. Rodway moved that the words "on the first Monday "of" be deleted from Rule 28, and the words "at least once" be substituted. Seconded by Mr. Walter E. Taylor and carried.

12th May, 1924.

The Monthly Meeting was held at the Society's Rooms on 12th May, Mr. L. Rodway, C.M.G., presiding.

Dr. Crowther drew attention to the proposal to carry on mining operations at the Fossil Cliffs on Maria Island. After

discussion it was resolved to inquire from the National Portland Cement Company concerning this matter, and if the reply was not favourable, to approach the Government.

A collection of Franklin MSS. was tabled and drawn attention to by Dr. Crowther and the Secretary, the papers being portion of a collection of original letters, etc., presented to the Society by W. F. Rawnsley, Esquire, and forwarded by the Agent-General from London.

The following were elected members of the Society:—Messrs. C. C. Crisp and A. P. Newall.

Illustrated Lecture.

Mr. M. S. R. Sharland delivered an illustrated lecture "On the Nomadic Migration of Tasmanian Birds."

9th June, 1924.

The Monthly Meeting was held at the Society's Rooms on the 9th June, Mr. L. Rodway, C.M.G., presiding.

Mr. N. Booth was elected a member of the Society.

Paper.

The following paper was read:—

Note on a Cliff Section near Cape Paul Lamanon. By A. N. Lewis, M.C., LL.B.

Dr. W. L. Crowther read Lady Franklin's diary of an excursion to Recherche Bay. A discussion followed, those taking part being the Chairman, Messrs. W. F. D. Butler, Courtney-Pratt, J. Moore-Robinson, L. F. Giblin, A. N. Lewis, and C. E. Lord.

10th July, 1924.

The Monthly Meeting was held at the Society's Rooms on 10th July, Mr. L. Rodway, C.M.G., presiding.

The following were elected members of the Society:—Messrs. F. A. Allen, Rupert Shoobridge, and Dr. D. C. Henry.

Papers.

The following papers were read:—

On Certain Tasmanian Pleistocene Marsupials. By H. H. Scott and Clive Lord.

Additions to the Fish Fauna of Tasmania. By Clive Lord

11th August, 1924.

The Monthly Meeting was held at the Society's Rooms on the 11th August, His Excellency the Administrator (Sir Herbert Nicholls) presiding.

Dr. W. H. Bennett and Mr. C. W. Calver were elected members of the Society.

Illustrated Lecture.

Dr. George Horne delivered an illustrated lecture on Central Australia. At the conclusion of the lecture there was a short discussion. Appreciative reference was made to the fact that Doctor Horne had made a special visit to Tasmania for the purpose of delivering his lecture.

13th October, 1924.

The Monthly Meeting was held at the Society's Rooms on the 13th October, Mr. L. Rodway, C.M.G., presiding.

The following were elected members of the Society:—Colonel R. P. Smith and Mr. R. W. Legge.

Paper.

The following paper was read:—

A Geological Reconnaissance of the Lake St. Clair district. By W. H. Clemes, B.A., B.Sc.

Illustrated Lecturettes.

The following lecturettes were delivered:—

(1) The Evolution of Chitons. By Edwin Ashby.

(2) A Visit to Trinal (Java). By H. Sefton-Jones.

10th November, 1924.

The Monthly Meeting was held at the Society's Rooms on the 10th November, Mr. L. Rodway, C.M.G., presiding.

Papers.

The following papers were read:—

Tasmanian *Discomycetes*. By L. Rodway, C.M.G.

Notes on Some Tasmanian Mesozoic Plants. By A. B. Walkom, D.Sc.

Illustrated Lecture.

Reverend W. Corly Butler delivered an illustrated lecture "On the Problem of Mars."

1st December, 1924.

The Monthly Meeting was held at the Society's Rooms on the 1st December, 1924, Mr. L. Rodway, C.M.G., presiding.

The following members were elected:—Messrs. F. W. Heritage and W. A. Corstorphan.

Papers.

The following papers were read:—

Notes on the Habits of the Extinct Tasmanian Race. By W. L. Crowther, D.S.O., M.B.

The Penetrating Radiation in the Atmosphere at Hobart. By A. L. McAulay, B.Sc., and Miss Hutchison.

Illustrated Lecture.

Mons. H. Segaert, Consul-General for Belgium, delivered an illustrated lecture on "Belgian Life and Industries."

ANNUAL REPORT

1924.

The Royal Society of Tasmania

LIST OF MEMBERS

Honorary Members:

David, Sir T. W. Edgeworth, K.B.E., C.M.G., B.A., F.R.S., F.G.S. Professor of Geology and Physical Geography in the University of Sydney, the University, Sydney.
Mawson, Sir Douglas, B.E., D.Sc., O.B.E. Professor of Geology and Mineralogy, the University, Adelaide.
Spencer, Sir William Baldwin, K.C.M.G., M.A., D.Sc., Litt. D., F.R.S. Melbourne.

Year of Election.

Corresponding Members:

1901 Benham, W. B., M.A., D.Sc., F.R.S., F.Z.S. Professor of Biology, University of Otago, Dunedin, N.Z.
1892 Bragg, W. H., M.A., F.R.S. Professor of Physics in the University College, London.
1901 Chapman, R. W., M.A., B.C.E. The University, Adelaide.
1892 Dendy, A., D.Sc., F.R.S., F.L.S. "Vale Lodge," Hampstead, London, N.W.
1902 Haswell, W., M.A., D.Sc. The University, Sydney.
1875 Liversidge, Professor A. "Fieldhead," Coombe Warren, Kingston, Surrey, England.
1902 Maiden, J. H., I.S.O., F.R.S., F.L.S. "Levenshulme," Turramurra Avenue, Sydney.
1901 Smith, R. G., D.Sc., Linnean Hall, Linnean Society of N.S.W. 16 College Street, Sydney.
1892 Thompson, G. M., F.L.S. Dunedin, N.Z.
1901 Wall, A., M.A. Canterbury College, Christchurch, N.Z.

Life Members:

1918 Avery, J. 52 Southerland Road, Annandale, Melbourne.
1908 Baker, H. D. American Consular Service, Washington.
1890 Foster, Lieut.-Col. Henry. Merton Vale, Campbell Town.
1905 Foster, J. D. "Fairfield," Epping.
1905 Grant, C. W. "High Peak," Huon Road.
1921 Harvey, D. H. "Manresa," Lower Sandy Bay.

Year of Election.

1922 Jones, Sir Henry. Campbell Street, Hobart.
1894 Mitchell, J. G. Parliament Street, Sandy Bay.
1896 Sprott, G., M.D. Town Hall, Hobart.

Members:

1922 Adams, A. W. National Mutual Buildings, Hobart.
1923 Agnew, Miss K. Augusta Road, New Town.
1921 Allen, D. V., B.Sc. Launceston Technical School, Launceston.
1924 Allen, F. A. 13 Franklin Street, West Hobart.
1921 Anderson, G. M., M.D., C.M. Clare Street, New Town.
1923 Atkinson, Rev. H. B. Hobart.
1921 Baker, H. S., LL.B., M.A. Griffiths, Crisp, and Baker, Collins Street.
1922 Bamford, H. Messrs. Noyes Bros., Macquarie Street, Hobart.
1887 Barclay, D. 143 Hampden Road, Hobart.
1921 Barr, J. S., M.D. (Glasgow). Lower Sandy Bay.
1890 Beattie, J. W. 28 Jordan Hill Road.
1918 Bellamy, H. City Engineer, Town Hall, Hobart.
1924 Bennett, Dr. H. W., L.D.S., D.D.S. Brisbane Street, Launceston.
1903 Bennett, W. H. "Ashby," Ross.
1920 Bernacchi, A. G. D. Maria Island.
1921 Bertouch, V. Von. Wellington Square Practising School, Launceston.
1921 Bethune, Rev. J. W. Church Grammar School, Launceston.
1921 Birchall, J. A. 118 Brisbane Street, Launceston.
1922 Biss, F. L. U.S.S. Co., Hobart.
1912 Black, R. A. Department of Agriculture, Hobart.
1909 Blackman, A. E. Franklin.
1920 Blaikie, T. W. Practising School, Elizabeth Street, Hobart.
1924 Booth, N. P. Messrs. Cadbury-Fry-Pascall Ltd., Claremont.
1918 Bowling, J. "Barrington," Tower Road, New Town.
1923 Breaden, J. C. 12 Waverley Avenue, New Town.
1923 Brett, R. G. 53a Hill Street, Hobart.
1917 Brettingham-Moore, E., M.B., Ch.M. Macquarie Street, Hobart.
1911 Brooks, G. V. Director of Education, Hobart.

Year of Election.

1921 Brown, Mrs. Justin. "Waratah," York Street, Launceston.
1922 Brownell, C. C. 117 Hampden Road, Battery Point.
1907 Brownell, F. L. "Berwyn," Mercer Street, New Town.
1924 Budge, E. A., B.Sc. 302 Argyle Street, Hobart.
1918 Burbury, Alfred. "Glen Morey," Antill Ponds.
1919 Burbury, Charles. "Brookside," Moonah.
1918 Burbury, Frederick. "Holly Park," Parattah.
1919 Burbury, Gerald. "Syndal," Ross.
1919 Burbury, T. J. "Park Farm," Jericho.
1923 Butler, Mrs. G. H. Augusta Road, New Town.
1909 Butler, W. F. D., B.A., M.Sc., LL.B. Bishop Street, New Town.
1921 Butler, Rev. W. Corly. The Parsonage, Melville Street, Hobart.
1924 Calver, C. W. 112 Brisbane Street, Launceston.
1921 Camm, Dr. C. George Street, Launceston.
1920 Cane, F. B. 90 High Street, Sandy Bay.
1919 Chapman, A. D. Collins Street, Hobart.
1912 Chapman, Hon. J. R. Holebrook Place, Hobart.
1913 Chepmell, C. H. D. Clerk of the Legislative Council, Hobart.
1920 Clark, W. I., M.B. Macquarie Street, Hobart.
1896 Clarke, A. H., M.R.C.S., L.R.C.P. "The Glen," Private Bag, St. Mary's.
1918 Clarke, T. W. H. Quorn Hall, Campbell Town.
1910 Clemes, W. H., B.A., B.Sc. Clemes College, Hobart.
1922 Collier, J. D. A. The Librarian, Tasmanian Public Library, Hobart.
1917 Copland, D.B., M.A. Professor of Economics, University, Melbourne.
1924 Crabtree, R. W. Queen's College, the University, Melbourne.
1920 Cranstoun, Mrs. F. A. 6 Gregory Street, Sandy Bay.
1924 Crisp, Cecil C. Collins Street, Hobart.
1919 Crowther, W. L., D.S.O., M.B. Macquarie Street, Hobart.
1917 Cullen, Rev. John. Macquarie Street, Hobart.
1918 Cummins, W. H., A.I.A.C. Manager "Mercury" Office, Hobart.
1922 Davidson, R. Huon Timber Co., Hobart.
1924 Davies, G. B. 111 Warwick Street, Hobart.
1919 Davies, H. W. "Abermere," Mount Stuart.

Year of Election.

1923 Davis, Alfred. Lord Street, Sandy Bay.
1923 Davis, Charles. Red Chapel Road, Lower Sandy Bay.
1908 Dechaineux, L. Technical College, Hobart.
1903 Delany, Most Rev. Patrick, Archbishop of Hobart. 99 Barrack Street.
1921 Dryden, M.S. 13 Hillside Crescent, Launceston.
1921 Eberhard, E. C. Charles Street, Launceston.
1923 Edwards, Hon. F. B., M.L.C. Ulverstone.
1919 Elliott, E. A., M.B. Main Road, New Town.
1918 Ellis, F. Education Department, Hobart.
1921 Emmett, E. T. Railway Department, Hobart.
1921 Erwin, H. D. Hutchins School, Hobart.
1918 Evans, L. Acting Director of Agriculture, Hobart.
1921 Eyre, H. Manual Training School, Launceston.
1902 Finlay, W. 11 Secheron Road, Hobart.
1918 Fletcher, C. E. Education Department, Hobart.
1921 Flounders, A. 102 Patterson Street, Launceston.
1909 Flynn, T. T., D.Sc. The University, Hobart.
1921 Forward, J. R. Mechanics' Institute, Launceston.
1921 Fox, Miss. Ladies' College, Launceston.
1922 Gatenby, Miss M. 1 Tulloch Street, Launceston.
1918 Gatenby, R. L. Campbell Town.
1923 Gibbings, R. A. C. 28 Antill Street, Hobart.
1922 Giblin, A. V. King Street, Sandy Bay.
1908 Giblin, Major L. F., D.S.O., B.A. Davey Street.
1924 Giblin, Dr. W. W. Macquarie Street, Hobart.
1920 Gillies, J. H. Macquarie Street, Hobart.
1923 Gorringe, J. A. Kempton, Tasmania.
1923 Gould, H. T. Liverpool Street, Hobart.
1918 Gould, J. W. Tramways Department, Hobart.
1907 Gould, R. Longford.
1924 Gray, H. Fitzroy Place, Hobart.
1923 Green, Dr. A. W. 30 Parliament Street, Sandy Bay.
1921 Hall, E. L. 38 Lyttleton Street, Launceston.
1922 Halligan, G. H., F.G.S. 98 Elphin Road, Launceston.
1913 Hardy, G. H. The University, Brisbane.
1923 Harley, R. Institution for Blind, Deaf, and Dumb, Hobart.
1918 Harrap, Lieut.-Col. G. Launceston.
1921 Harris, Miss Ila. Findlay's Buildings, Launceston.
1921 Harris, Dr. R. E. 73 Cameron Street, Launceston.
1924 Hawker, Mrs. J. F. 204 Davey Street, Hobart.
1913 Hawson, Edward. "Reminé," 174 Argyle Street, Hobart.

Year of Election.

1919 Hay, Rt. Rev. R. S., D.D., Bishop of Tasmania. Bishopscourt, Hobart.

1924 Henry, Dr. D. C., M.B., F.R.C.S. St. John Street, Launceston.

1921 Heritage, J. E. 76 Frederick Street, Launceston.

1921 Heyward, F. J., F.R.V.I.A. 43 Lyttleton Street, Launceston.

1915 Hickman, V. V., B.Sc. Mulgrave Crescent, Launceston.

1921 Hill, A. H. 143 Charles Street, Launceston.

1914 Hitchcock, W. E. Moina, Tasmania.

1918 Hogg, G. H., M.D., C.M. 37 Brisbane Street, Launceston.

1921 Hogg, W. Public Buildings, Launceston.

1922 Hood, F. W. Customs House, Hobart.

1921 Horne, G., V.D., M.D., M.A., Ch.B. Lister House, Collins Street, Melbourne.

1921 Horner, A. G. 16 York Street, Launceston.

1923 Hudspeth, W. H. "The Nook," Lower Sandy Bay.

1923 Hungerford, Mrs. "Red House," Fern Tree.

1922 Hungerford, Miss. "Red House," Fern Tree.

1923 Hurst, Miss R. 39 Bay Road, New Town.

1909 Hutchison, H. R. 1 Barrack Street, Hobart.

1922 Huxley, G. H., M.A. Kent Avenue, W. Hobart.

1913 Ife, G. W. R., LL.B. Mortimer Avenue, New Town.

1918 Irby, L. G. Conservator of Forests, Forestry Department, Hobart.

1898 Ireland, E. W. J., M.B., C.M. Launceston General Hospital.

1919 Jackson, George A. 79 Collins Street, Hobart.

1906 Johnson, J. A., M.A. Training College, Hobart.

1922 Johnson, W. R. Clemes College, Hobart.

1922 Johnston, J. R. Murray Street, Hobart.

1921 Judd, W., M.A. College Street, Launceston.

1911 Keene, E. H. D. Burnie.

1921 Keid, H. G. W. Powelton, via Yarra Junction, Victoria.

1922 Kemp, Andrew. Stoke Street, New Town.

1922 Kennedy, J. New Wharf, Hobart.

1924 Kennedy, Mrs. J. 96 Montpelier Road.

1910 Kermode, R. C. Mona Vale, Ross.

1918 Knight, C. E. L., B.Sc. Claremont.

1919 Knight, H. W. National Mutual Buildings, Macquarie Street.

Year of Election.

1913 Knight, J. C. E. Claremont.

1924 Legge, R. W. Cullenswood, Tasmania.

1919 Lewis, A. N., M.C., LL.B. "Werndee," Augusta Road, New Town.

1887 Lewis, Sir N. E., K.C.M.G., M.A., B.C.L., LL.B. Augusta Road, New Town.

1912 Lindon, L. H. "The Lodge," Park Street, Hobart.

1900 Lines, D. H. E., M.B., Ch.B. Archer Street, New Town.

1921 Listner, W. P., M.A., LL.B. 2 Byron Street, Sandy Bay.

1921 Lord, Chester. "Mellifont," High Street, Sandy Bay.

1912 Lord, Clive E., F.L.S. "Cliveden," Sandy Bay.

1921 Lord, Raymond. "Handroyd," 6 Franklin Street, Hobart.

1924 Lord, Ronald. Derwentwater Avenue, Sandy Bay.

1922 Low, H. M. "The Gables," Pottery Road, New Town.

1912 McAlister, Miss M. K. Holebrook Flats, Davey Street, Hobart.

1893 McAulay, Professor Alex., M.A. The University, Hobart.

1923 McAulay, A. L., Ph.D. The University, Hobart.

1921 McClinton, Dr. R. 70 St. John Street, Launceston.

1919 Mackay, A. D. 83 Patterson Street, Launceston.

1922 Macleod, Mrs. L. H. High Street, Sandy Bay.

1918 Mansell, A. E. 331 Davey Street, Hobart.

1924 Marsh, James. "Westella," Elizabeth Street, Hobart.

1918 Martin, Brig.-Gen. W. Launceston.

1921 Masters, A. H. A.M.P. Chambers, Launceston.

1913 Mather, J. F. 15 Church Street, Hobart.

1895 May, W. L. Forest Hill, Sandford.

1921 Meston, A. L. 115 Canning Street, Launceston.

1909 Millen, Senator J. Roxburgh, Newstead.

1907 Miller, L. S., M.B., Ch.B. 156 Macquarie Street, Hobart.

1921 Miller, R. M. State High School, Launceston.

1911 Montgomery, R. B. "Astor," Macquarie Street, Hobart.

1918 Murdoch, Hon. Thomas. 55 Montpelier Road, Hobart.

1921 Muschamp, Rev. E. Holy Trinity Rectory, Launceston.

1924 Newall, A. P. Charles Street, Moonah.

1882 Nicholas, G. C. "Cawood," Ouse.

1918 Nicholls, Sir H., Chief Justice of Tasmania. Pillinger Street, Sandy Bay.

Year of Election.	
1910	Nicholls, H. M. Department of Agriculture, Hobart.
1921	Nye, P. B., M.Sc., B.M.E. Geological Survey Office, Hobart.
1917	Oldham, N. New Town.
1921	Oldham, W. C. 39 George Street, Launceston.
1919	Oldmeadow, H. E. R. "Roseneath," Austin's Ferry.
1924	Oliver, H. Lindisfarne.
1922	Overell, Miss Lilian. Holebrook Place.
1921	Padman, R. S. 56 St. John Street, Launceston.
1923	Parker, Dr. G. M. Swansea, Tasmania.
1922	Parker, H. T. Training College, Hobart.
1921	Parker, R. L. 81 St. John Street, Launceston.
1908	Parsons, C. J. 190 Davey Street, Hobart.
1921	Patten, W. H. 59 Cameron Street, Launceston.
1923	Pedder, A. Stoke Street, New Town.
1922	Perrin, Miss K. 16 York Street, Launceston.
1902	Piesse, E. L. "Merridale," Sackville Street, Kew, Melbourne.
1910	Pillinger, J. 4 Fitzroy Crescent, Hobart.
1918	Pitt, F. C. K. "Glen Dhu," The Ouse.
1908	Pratt, A. W. Courtney. "Athon," Mount Stuart Road.
1923	Pulleine, R., M.B. 163 North Terrace, Adelaide.
1923	Purcell, G. A. Clemes College, Hobart.
1921	Reid, A. McIntosh. Geological Survey Office, Hobart.
1922	Reid, A. R. Curator, Beaumaris Zoo, Domain, Hobart.
1921	Reid, W. D. Public Buildings, Launceston.
1921	Reynolds, John. Knocklofty Terrace, Hobart.
1919	Riggall, Capt. A. H. Tunbridge.
1912	Robinson, J. Moore-. Chief Secretary's Department, Hobart.
1884	Rodway, L., C.M.G. 77 Federal Street, Hobart.
1923	Rogers, G. H. B. 204 Davey Street, Hobart.
1921	Rolph, W. R. "Examiner" and "Courier" Office, Launceston.
1913	Ross, Hector. Cambridge.
1922	Sargison, H. Elizabeth Street, Hobart.
1921	Scott, H. H. Curator, Victoria Museum, Launceston.
1896	Scott, R. G., M.B., Ch.M. 172 Macquarie Street, Hobart.
1921	Sharland, M. S. R. "The Mercury" Office, Hobart.
1921	Shields, Hon. Tasman. 13 Patterson Street, Launceston.
1921	Shoobridge, Hon. L. M. "Sunnyside," New Town.

ERRATA

(1) Page 3, line 2, for ${}^{c}\lambda$ read ${}^{l}\lambda$.

(2) Page 5, line 1, delete Δ before $\log l$.

(3) Page 13, line 17, after $-V_0\sigma_9{}^{l}U\Delta_9$ add "where ${}^{l}U$ is a co-exco vector linity density.

(4) Page 14,

(a) Line 11, eq. (24), for ${}^{c}w$ read ${}^{c}u$.

(b) eq. (25), for $\sum\{d\xi\,{}^{c}v, {}^{c}w\}$ and $\sum\{d\xi'\,{}^{c}w, {}^{c}v\}$ read $\sum\{d\xi\,{}^{c}v, {}^{c}u\}$ and $\sum\{d\xi'\,{}^{c}u, {}^{c}v\}$ respectively.

(c) line 20 after "referred" insert "to".

(5) Page 16,

(a) lines 11 to 14 insert commas between pairs $(\epsilon\epsilon)$, $(\zeta\zeta)$ etc.

(b) eq. (30) for $(\iota_\alpha, \iota_\alpha{}^{-1})$ read $(\iota_a, \iota_a{}^{-1})$ and before $= \sum(\overset{e}{i}, \overset{e}{i}{}^{-1})$ add (e, e)

(6) Page 17, line 19 after "supposed" insert "to be".

(7) Page 19, line 21, for "that" read "than".

(8) Considerable confusion in the references renders the following changes important.

(a) Page 2, line 7, for ${}^{(1)}$ read ^{1}

(b) Page 14, line 20, for (2) read ^{2}

(c) Page 20, line 17. for (1) read ^{1}, line 23, for (2) read ^{2}.

(d) Page 20, under "References", for M.D.I. (I), (II), (III), read M.D.I. (1), (2), (3) in all places.

(Added Nov. 1924)

As there have been several months of unavoidable delay in issuing this first paper, the opportunity is taken of adding:-

(1) Some further observations on the calculus used in this series of researches.

(2) A statement of the large assistance received from others that has made publication possible in face of the inherent difficulties.

(3) Additions and corrections.

(1) Our Aims. As dead as the Sanskrit language. Such is the reason given by a referee of the Royal Society of London why henceforth nothing should ever be published in Quaternions; and this advice has been accepted by the Society. If all mathematicians of the present day share this view then these papers must be regarded as addressed to a future generation.

In a popular history of mathematics of about the year 2000 we may expect to find some such account as follows:-

"The reader will now realise that the swift advance of mathematical physics of the last half century has been largely due to the universal use of the vector calculus. It is difficult to explain why the development was so long delayed, but we ought to attempt at least a partial solution.

"The fact seems to be that between 1850 and 1950 nearly all mathematicians failed to make a very necessary distinction. During those years there were extant many vector methods and but one vector calculus. The unique calculus demanded a little preliminary effort to learn, and the many methods made no such demand.

"About 1890, when the many methods were just beginning to emerge, after a controversy the mathematical world made its choice — the indolent one. Between 1920 and 1930 a writer not inaptly described the sit-

uation by paraphrasing the words of the prayer-book thus: 'They have erred and strayed from the way like lost sheep; they have followed too much their own devices; and there is no help in them.'

"What was the predominant feeling of those few pioneers who kept on adding to the world's area of reclaimed land though their contemporaries could not be induced duced to come and inspect it? In such important mat--ters as the application of covariants and contravariants to mathematical physics; in proving intergration theorems of which the meaning remained utterly unknown; in providing a quite comprehensive and logically sound dynamical basis for the electromagnetic field; in these and other respects the pioneers were a full thirty years in advance of their generation. They would naturally expect to receive some tardy assurance that all their labours under the sun had not been utterly thrown away, but instead of this they were informed that their writings were so useless that for the future they would not be published. We return to our question, what was the mental attitude generated in the recipients of this uniform ignoration of their work? Probably they had such meagre satisfaction as results from a consciousness of having duly performed a necessary thankless task for their fellows. Whether any fruitful consequences should follow must be left to the fates to decide."

For the furtherance of our aims, the advance of general relativity, the writer believes the means indicated above are far superior to those current to-day. He therefore deliberately continues to express the results of his researches in that quaternion form in which they grew.

(2) Acknowledgements. The past seven months have been none too long for the preliminary experiments needed to overcome the many special difficulties of issue. The work has been truly cooperative.

To Miss M. Clark the writer is beyond measure indebted for the fact that he is once more acquiring the beginnings of a mathematical library. She is not a professed mathematician, but it is extraordinary with what unerring skill she has been able to follow the tortuous changes of convention that have occurred in the writer's difficult task of rendering modern mathematics into a braille form.

In April we were still uncertain whether the form of reproduction the reader sees before him would prove the most suitable. That it was finally adopted is mostly due to the ungrudging labour and patent success of R.G.Brett B.Sc. in the transcription by hand of the technical mathematical parts as a preliminary to the work of the photographer and printer. During the past half year, a period of inefficient knowledge of the braille character on the part of the writer, the assistance rendered to him by F.M.Young B.A. has been invaluable in the matter of the drafting and composition of the whole paper.

It can scarcely be hoped that even when the mode of reproduction ceases to be novel we shall ever be capable of freedom from typographical errors whose absence should be expected were ordinary printing at our disposal.

(3) Additions and Corrections. The present opportunity is taken of adding to the new notations of Art. 5 eq. (31) another whose want the writer has felt from as early as 1887. ${}_{\sigma}\triangle$, ${}_{q}\triangle$, ${}_{\phi}\mathrm{C}$ are analogous symbols whose pre-suffix is a very inconvenient symbol to print, especially if of any complexity such as when

$$\phi = V_1(\ )\omega$$

I have recently thought of a mode of dealing with these worth adopting permanently; and shall henceforth freely use the notation about to be described. Put

$${}_{q}\triangle = \%_{q}, \qquad {}_{\phi}\mathrm{C} = \%_{\phi} \qquad (A)$$

The symbol $\%_0$ should always be read as "rate - per" and should never occur without its immediately following independent variable (the q or ϕ of (A).) Thus it is never to be used in place of Δ ; the new equivalent of Δ is $\%_0\rho$, though doubtless it will prove convenient to retain Δ as an alternative of $\%_0\rho$. The sign to be attached to $\%_0$ is given thus: let X be any function of the independent q or ϕ. Then without exception the following is to be true.

$$\left.\begin{aligned} dX &= V_0 dq \%_0 q \cdot X , \\ dX &= V_0 d\phi e \%_0 \phi e \cdot X \end{aligned}\right\} \qquad (B)$$

It may be noted that $\%_0$ is the analogue of ∂/∂ in $(\partial/\partial x)$.

RESEARCHES IN RELATIVITY

I. CRITICISM AND MODIFICATION OF EINSTEIN'S LATEST MANIFOLD

By Alex. McAulay, M.A.

Professor of Mathematics University of Tasmania

(Read 14th. April, 1924)

Art. 1. Introductory.

This is the first of a series of investigations concerning which details will be given at the end of the paper.

In "Nature" of September 1923 p.448 ("The Theory of the Affine Field") Einstein describes a remarkable mathematical discovery. He develops from Eddington's previous work a perfectly satisfactory basis for the Riemann manifold required for mechanics and gravi-tation in the general theory of Relativity. His main object, however, was to include provision also for the electro-magnetic field, but it would appear that his conclusions on this part of the development are irreconcilable with observation. If he had examined in detail the mechanical stresses, which he could have done by the conditions imposed by the fact that the action is an invariant density, he would have found that his constant γ cannot be "practically in-definitely small" as he states it should be for an-other reason. The truth of this remark will appear in the subsequent work.

It is, however, easy to modify the principle from which he works by increasing the 40 scalars from which he starts to 41. It is only necessary to ass-ume that in a parallel displacement α of a four di-mensional element $db = dx_1 dx_2 dx_3 dx_4$ the element suffers a definite intrinsic increase in bulk. If at a selected point the measure of the bulk of an element db is taken to be $dB = e^x db$, then the measure of bulk of a second element db' will be $dB' = e^x db'$. Our addition to Einstein's prin-ciple is that the proportional increment of bulk namely

$$\left(d_\alpha^{PD} . dB\right) / dB = V_0 \alpha (\Delta x - E_\epsilon \epsilon) \mathrel{\underset{r}{=}} V_0 \alpha^\epsilon \lambda \qquad (1)$$

is intrinsic, that is $\Delta x - E_\epsilon \epsilon$ is covariant (and therefore put $= {}^c\lambda$), and that the action remains stationary when x as well as the other forty scalars is arbitrarily varied.

Art. 2. Statement of the results.

The notation here used will be found in three pap--ers by the present writer (1) to which the reader is referred.

We shall use $E_\alpha, F_\alpha, C_\omega, \Omega$ for our former E_α', F_α', C_ω', Ω', also we shall write $-\Delta = \nabla$ in place of ∇, and (ϵ, ϵ) in place of $-(\zeta, \zeta)$; also ${}^lQ, {}^dQ, {}^cQ$ in place of $Q^{\cdot}, Q^{\cdot\times}, Q^\times$. The rea--sons for these changes in notation will be found in Art. 5. below.

Einstein's tensor symbols $\mathfrak{H}\cdot, \mathfrak{H}^*, \Gamma^\sigma_{\mu\nu}, R_{\mu\nu}$, $\gamma_{\mu\nu}, \phi_{\mu\nu}, g^{\mu\nu}, \mathfrak{f}^{\mu\nu}, \mathfrak{i}^\mu$,

are the equivalents of our multenion symbols

${}^lH, {}^lH^*, C_\omega, \Omega, \psi, {}^c\omega, {}^d\psi, {}^l\omega, {}^l\kappa$.

$-E_\alpha'\beta$ is the increment in β (contravariant) due to a paralell displacement α. From it the invariant--ive $C_\omega {}^c\gamma$ is formed expressing the increment in ${}^c\gamma$ when it is moved by parallel displacements round an infinitesimal circuit $\omega = V_2\alpha\beta$. C_ω gives by the process known as contraction the coexcontra $\Omega\alpha$ where

$$\left.\begin{aligned}\Omega\alpha &= -E_{g\alpha}\Delta_g + V_0\alpha\Delta . E_\epsilon\epsilon \\ &\qquad + E_\epsilon E_\alpha\epsilon - E_\alpha E_\epsilon\epsilon \\ &= \psi\alpha - \tfrac{1}{2}V_1{}^c\omega\alpha\end{aligned}\right\} \qquad (2)$$

where ψ is the self-conjugate part of Ω. ${}^lH$ is a function of the 41 scalars of (E_α, x) and in par--ticular is assumed to be a function of Ω and ${}^c\lambda$. The 41 scalars (E_α, x) are given arbitrary variations which are zero at the boundary of any arbitrarily chosen region, and it is assumed that $\int^n\!\!\int {}^lH\,db$ remains stationary. Thus 41 equations are furnished

for the original scalars (E_α , x).

Define ${}^d\Omega$, ${}^d\psi$, ${}^l\omega$, ${}^c\lambda$ by the equations

$$\left.\begin{aligned} d^l\mathrm{H} &= \mathrm{V}_0{}^d\Omega e d\Omega e + \mathrm{V}_0{}^l\lambda d{}^c\lambda \\ &= \mathrm{V}_0{}^d\psi e d\psi e + \mathrm{V}_0{}^l\omega d{}^c\omega \\ &\quad + \mathrm{V}_0{}^l\lambda d{}^c\lambda \end{aligned}\right\} \tag{3}$$

The notation (e , e) is defined in Art. 5 below as $\Sigma\,(i , i^{-1})$.

By (3) $$ {}^d\Omega\, {}^c\alpha = {}^d\psi\, {}^c\alpha + \mathrm{V}_{,1}{}^l\omega\, {}^c\alpha \tag{4}$$

and ${}^d\psi$ is the self-conjugate part of ${}^d\Omega$.

I will now mention the identifications which we make of these symbols in the combined gravitational and electro-magnetic field, then state the general results that follow from the principle that has been laid down. In the next article an outline of the quite simple reduction which leads to these results is given.

${}^d\psi$ is identified with $l\theta^{-1} = {}^d\theta$ where $l = |\theta^{\frac{1}{2}}|$ and θ is looked on as the linity furnishing a standard or fundamental quadratic form $\mathrm{V}_0 d\rho\theta d\rho$

${}^l\omega$ is the magnetic force cum displacement ${}_n\mathrm{V}_2$: (we shall consider our manifold to be of n dimensions from henceforth). ${}^l\lambda$ is the momentum-mass-energy vector. ψ is the curvature linity; the total energy linity ${}^d\mathrm{T}$ has exactly the same relation with this as is usually postulated for the gravitational field. $-{}^c\omega$ (our former $-\omega^{x}$) is the magnetic induction cum electrostatic force. Finally ${}^c\lambda$ is the potential vector. Note very particularly that the results, about to be given, in no wise require us to state what is the form of ${}^l\mathrm{H}$ in terms of Ω and ${}^c\lambda$, and yet they contain practically the whole of what is be--lieved in the general theory of relativity.

The results that follow from our action-principle are

$${}^l\kappa = -\mathrm{V}_1\Delta\, {}^l\omega , \mathrm{V}_0\Delta{}^l\lambda = \mathrm{V}_0\Delta\, {}^l\kappa = 0 \tag{5}$$

(The first of these is to be regarded as a definition of the symbol ${}^{l}\kappa$.)

$$({}^{l}\lambda + {}^{l}\kappa) + \tfrac{1}{2}(n-1)(n-2)\,{}^{d}\theta({}^{c}\lambda - \Delta y) = 0 \qquad (6)$$

The statement $V_0 \Delta {}^{l}\lambda = 0$ expresses the conservation of mass-energy, a highly satisfactory deduction from the present theory.

$$ {}^{c}\omega = V_2 \Delta {}^{c}\lambda , \qquad V_3 \Delta {}^{c}\omega = 0 \qquad (7)$$

${}^{l}H^{*}$ is the function reciprocal to ${}^{l}H$ with regard to Ω and ${}^{c}\lambda$ and is therefore taken as an explicit function of ${}^{d}\Omega$ and ${}^{l}\lambda$. Thus

$$\left.\begin{aligned}
{}^{l}H + {}^{l}H^{*} &= V_0 \Omega e\, {}^{d}\Omega e + V_0 {}^{c}\lambda\, {}^{l}\lambda \\
&= V_0 \psi e\, {}^{d}\psi e + V_0 {}^{c}\omega\, {}^{l}\omega \\
&\quad + V_0 {}^{c}\lambda\, {}^{l}\lambda \\
{}^{d}\psi &= {}_{\psi}\mathbb{C}\, {}^{l}H, \quad {}^{l}\omega = {}_{c\omega}\Delta\, {}^{l}H, \\
{}^{l}\lambda &= {}_{c\lambda}\Delta\, {}^{l}H, \quad \psi = {}_{d\psi}\mathbb{C}\, {}^{l}H^{*}, \\
{}^{c}\omega &= {}_{l\omega}\Delta\, {}^{l}H^{*}, \quad {}^{c}\lambda = {}_{l\lambda}\Delta\, {}^{l}H^{*}
\end{aligned}\right\} \qquad (8)$$

$$ {}^{l}T\, {}^{c}\alpha = 2\psi\, {}^{d}\theta - V_0 \epsilon \psi\, {}^{d}\theta \epsilon \qquad (9)$$

$$ V_1({}^{l}\lambda - {}^{l}\kappa)\, {}^{c}\omega + {}^{l}T_{\epsilon}\, \epsilon = 0 \qquad (10)$$

The kind of absolute differentiation here indicated by the suffix ϵ is that which results from a Riemann manifold: it is the ordinary absolute differentiation which is meant: generally below this is not the case, the differentiation requiring the use of our present E_α in place of that portion of it, F_α , defined in equations (12),(13) below. Next we have

$$ {}^{c}\lambda = \Delta y + (\Delta \log l - E_{\epsilon}\, \epsilon) \qquad (11)$$

where y is the invariant $x - \Delta \log l$; (x is not invariant); and

$$\left.\begin{aligned} E_\alpha{}'\beta &= \theta^{-1}\Gamma_\alpha{}'\beta, \quad \Gamma_\alpha{}'\beta = \Theta_\alpha{}'\beta + \Phi_\alpha{}'\beta, \\ \Theta_\alpha{}'\beta &= \tfrac{1}{2}(V_0\alpha\Delta\,.\,\theta\beta + V_0\beta\Delta\,.\,\theta\alpha - \Delta V_0\alpha\theta\beta), \\ (n-1)(n-2)\,\Phi_\alpha{}'\beta &= \theta[\alpha V_0\beta\theta(\lambda+\kappa) \\ &\quad + \beta V_0\alpha\theta(\lambda+\kappa) \\ &\quad - (n-1)(\lambda+\kappa)V_0\alpha\theta\beta] \end{aligned}\right\} \tag{12}$$

In connection with (12) it is convenient to define $F_\alpha{}'\beta$ and $G_\alpha{}'\beta$ thus

$$\left.\begin{aligned} F_\alpha{}'\beta &= \theta^{-1}\Theta_\alpha{}'\beta, \quad G_\alpha{}'\beta = \theta^{-1}\Phi_\alpha{}'\beta \\ E_\alpha{}'\beta &= F_\alpha{}'\beta + G_\alpha{}'\beta \end{aligned}\right\} \tag{13}$$

of two parts of $\Gamma_\alpha{}'\beta$ in (12) the first $\Theta_\alpha{}'\beta$ is not invariantive, and the second is. Similarly for (13)

It is the results given, up to (12), of which we have postponed till next article the simple establish--ment. We will here first make some remarks on (9) and (10) and the following obtained by eliminating the potential vector ${}^c\lambda$ from the above results,

$$-\tfrac{1}{2}(n-1)(n-2)\,{}^c\omega = V_2\Delta[{}^d\theta^{-1}({}^l\lambda + {}^l\kappa)] \tag{14}$$

Our remarks will be on (A) the nature of the con--nection of (10) with the motion of matter and the modification of its form to one more near the usual; (B) the breaking up of (10) into three separate inde--pendent equations, the first involving ${}^d\theta$ only, the second ${}^d\theta$ and ${}^l\kappa$ only, and the third involving all three ${}^d\theta$, ${}^l\kappa$, and ${}^l\lambda$; and (C) the novelty of the expression for ${}^c\lambda$ in (6) and for ${}^c\omega$ in (14).

(A). Equation (10), with (9) to explain the mean--ing of ${}^d\mathrm{T}$, is an identity which does not in the

least depend on our principle of stationary action but is true simply because ${}^{l}\mathrm{H}$ is an invariant dens--ity. If, therefore, following Einstein, the reader should try some special assumption such as that ${}^{l}\mathrm{H}^* = -\frac{1}{2}l^{-1}V_0{}^{l}\omega\theta{}^{l}\omega$ and endeavour to derive information from (10) he will be disappointed; after his reduction he will discover that (10) gives $0 = 0$ and nothing else. The utility of (10) lies in the very fact that he will find this whatever legitimate special form he gives to ${}^{l}\mathrm{H}$; in a word, it is an identity. The very simple term $V_1{}^{l}\lambda{}^{c}\omega$ in (10) looks very different from the Newtonian md^2x/dt^2 or the usual generalisation thereof that appears in general relativity. But if we take the form in which it actually presents itself below in the next article, namely as

$$ {}^{c}\lambda V_0\Delta{}^{l}\lambda + V_1{}^{l}\lambda{}^{c}\omega = {}^{c}\lambda V_0\Delta{}^{l}\lambda + V_1{}^{l}\lambda V_2\Delta{}^{c}\lambda $$

we are at once guided to

$$ V_1{}^{l}\lambda{}^{c}\omega = {}^{c}\lambda_9 V_0\Delta_9{}^{l}\lambda_9 - \Delta_9 V_0{}^{c}\lambda_9{}^{l}\lambda \tag{15} $$

The second term on the right is made invariantive by adding to the same side of the equation $\mathrm{E}_{l\lambda}{}^{c}\lambda$ and therefore the first term by subtracting the same ex--pression from the same side, for the left side is invariantive; we will ignore these invariantive ad--ditions in our discussion.

The first term on the right of (15) is the accepted proper expression for the term corresponding in the general theory of relativity to Newton's $-md^2x/dt^2$ The second term is to be interpreted as a part of the radiation pressure which in the present theory is probably equal to ${}^{l}\mathrm{H}$. We reserve till our second paper a full discussion of this term $-\Delta_9 V_0{}^{c}\lambda_9{}^{l}\lambda$.

In anticipation, however, it is of interest to mention that I have already verified (1) that the identification of ${}^{l}H$ with the radiation pressure leads to essentially the current views thereof, but (2) that the term, while leaving "large scale phenomena" unaffected indicates a "flat contradiction to the Newtonian laws" when we attempt to apply them to "small scale phenomena" (Jeans' Report on the Quantum Intro. chap.)

Another aspect of the term is that ${}^{c}\lambda$ is the vector pontential. As usual the physical interpretation of ${}^{c}\lambda$ must be sought in its effect on ${}^{c}\omega$. The expression for ${}^{c}\omega$ in (14) is peculiar to the present theory, and is interesting in itself. It suggests what we know to-day for a fact, that wheresoever is a current there also is momentum. It is ordinarily assumed that in the ether both terms on the right of (14), or at anyrate the second, are zero. Relativists hitherto have failed to provide any invariantive flux of energy which shall serve to transfer energy across interstellar space. The present theory provides ${}^{l}\lambda$ (closely associated with the vector potential ${}^{c}\lambda$) to perform this duty.

The very direct manner in which both in (10) and in (14) the momentum vector ${}^{l}\lambda$ comes into comparison with the current vector ${}^{l}\kappa$ was no surprise to me. It seemed to me a merit and not a defect in the theory. In May 1923 I sent a series of seven letters to "Nature" which would have occupied in all less than seven pages, discussing the phenomena of quanta in the ether from the point of view of relativity. (The letters were returned as unsuitable for "Nature"). I pointed out that if relativity were true and also the conservation of energy, we were practically compelled to believe that in empty space the momentum vector ${}^{l}\lambda$ exists and satisfies precise conditions. The only simple view seemed to be that there was some universal natural constant expressing that wherever

there was electric current there was also a proportional amount of material momentum. I went so far as tentatively to suggest that the factor of conversion was m_1/e where e is the charge of an electron or a proton, taken as positive, and $m_1 = mm_0/(m+m_0)$ where m and m_0 are the masses of a proton and electron respectively; but I would not have it supposed that this is in any way involved in our present theory. Indeed I can see several reasons for thinking the ratio of conversion may be of quite a different order of magnitude.

(B) Notice that when we regard (2) as defining ψ in terms of E_α, the expression for ψ is linear in E_α so far as the two terms in Δ are concerned and is quadratic in the other two terms. In the same way E_α itself by (12) and ${}^c\omega$ by (14) are expressed linearly in terms of (Δ_9, θ_9), ${}^l\kappa$ and ${}^l\lambda$. We may suppose these values of ψ and ${}^c\omega$ substituted in the identity (10) which thus comes to be expressed in terms of the three symbols (involving twenty scalars) and their derivatives up to the second order. We have shown that this identity is true for arbitrary independent values of the three. It must therefore separate into three identities which are easily obtained in invariant form. If we put ${}^l\lambda = {}^l\kappa = 0$ we get the already famous identity for a Riemann manifold. (10) itself is a second of these three identities. The third is most conveniently obtained by putting ${}^l\lambda = 0$. This is the case which should have been considered by Einstein. Although the momentum vector does not appear, yet material force (in our notation $V_1 {}^c\omega\, {}^l\lambda$) due to current is brought into direct connection with the curvature, and as a consequence it seems to me that we ought to have $\gamma = 6\beta$ where β and γ are Einstein's constants. If this is correct, as already remarked, his theory is inconsistent with observation.

(C) It seems probable that in (6) Δy is as a

rule the chief term in the expression for $^c\lambda$ and that y is a natural measure of cosmic time, very nearly proportional to co-ordinate time when taken in a usual manner. If this is so $d\theta\, {}^c\lambda$ will be large compared with $^l\lambda$.

We may think of $V_0{}^l\lambda\Delta y$ as the true expression for material density in ordinary units; if so $^l\lambda\sqrt{(V_0\Delta y\partial^{-1}\Delta y)}$ would be very nearly the proper expression for the momentum vector density in the same units, with the same sense of "very nearly" as in the phrase two sentences above.

Further at this present moment of writing I lean towards the surmise that the total mass in the universe is exactly zero (as we all surmise about the charge). From the known data of the stars in the neighbourhood of the solar system we may suppose there is in such neighbourhood a uniform negative density of the order 1/200 ergs per c.c. on which is superposed the positive density due to radiation, about 2 close to the sun's surface and about 1/20,000 near the earth. I would suggest that possibly we have here (in the endowment of the ether with a negative material density) a hopeful method of overcoming some of the outstanding difficulties of radiation.

In this connection it may be observed that from (14) $^l\lambda$ and $^l\kappa$ cannot both in interstellar space be zero, and the former in particular must exist to account for energy flux. $^l\kappa$ is always assumed to be zero in empty space, but in my opinion without due warrant. The absence of dissipation of energy seems to me to involve only the less drastic condition

$$V_0\kappa\theta\kappa = 0$$

Art. 3. Proof of the results.

Before establishing the results of Art. 2 it is desirable to consider how expressions of the forms (Δ_9, Q_9) and $(\Delta_9, {}^lQ_9)$ are by supplementary additions made invariantive. Q is an invariantive multenion or multenion linity and ^lQ a corresponding

invariantive density. In the papers already referred to the six standard cases for Q have been fully dealt with by aid of our present $E_\alpha{}^c\beta$, and to deal with ^lQ is a simple matter. If ^lk is any scalar such that $^lk\,db$ is invariant and l is a particular case of ^lk which we take as a standard, then, of course, $^lk/l$ is an invariant and the difference of any two of the three vectors $E_\epsilon\epsilon$, $\Delta \log {}^lk$ and $\Delta \log l$ is a covariant vector. In the case of Q the supple--mentary addition may be written $(\epsilon, S_\epsilon Q)$ where $S_\epsilon Q$ is a definite bilinear function of ϵ and Q. (For instance, if $Q = \xi$ is a coexcontra multen--ion linity then if $({}^c\alpha, Q)$ is invariantive $(\Delta_g, Q_g) + (\epsilon, S_\epsilon Q)$ is also invariantive provided $-S_\epsilon \xi = E_\epsilon \xi + \xi E_\epsilon'$). In the case of ^lQ we have in addition to change Δ_g to any one of the three $\Delta_g - E_\epsilon\epsilon$, $\Delta_g - \Delta \log {}^lk$ or $\Delta_g - \Delta \log l$. This new supplement may however be incorporated with S_ϵ by changing S_ϵ to $S_\epsilon - V_0\epsilon E_{\epsilon'}\epsilon'$ and, when we please, we may use S_ϵ for this fuller form.

Let us now consider the application of our principle. In the first place it greatly simplifies matters to observe that in using equation (2) above to express $\delta\,{}^lH$ in terms of $\delta\Omega$ and $\delta\,{}^c\lambda$ the third and fourth terms of Ω can be entirely ignored. By making in--variantive every definite result obtained from our principle we ensure that the effect of these terms is taken account of. (If the reader does not consider this statement easy to establish he may use the ignor--ed terms throughout his work and he will find that he is led to precisely our results). We shall there--fore only write down the non-ignored terms, just as if they formed the whole of the expressions under consideration, except when we come to the definite stages of our results which we shall mark by numbered equations. In these we shall always insert the terms necessary to make the expressions invariantive. With this explanation we have:-

$$0 = \int^n \int \delta \, {}^l H \, db = \int^n \int db \left[V_0 {}^d \Omega \epsilon \, \delta \Omega \epsilon + V_0 {}^l \lambda \, \delta (\Delta x - E_\epsilon \epsilon) \right].$$

From the term in x we at once derive from our principle, that the equation of conservation of mass-energy, $V_0 \Delta {}^l \lambda = 0$, is true; and we may drop the x term. Thus

$$0 = \int^n \int db \left[V_0 {}^d \Omega \epsilon (- \delta E_{g.\epsilon} \Delta_g + V_0 \epsilon \Delta . \delta E_{\epsilon'} \epsilon') - V_0 {}^l \lambda \, \delta E_\epsilon \epsilon \right]$$

$$= \int^n \int db \left[V_0 \delta E_\epsilon \Delta_g {}^d \Omega_g \epsilon - V_0 \delta E_\epsilon \epsilon ({}^d \Omega_g \Delta_g + {}^l \lambda) \right]$$

Hence

$$0 = V_0 \delta E_\epsilon \epsilon' \left[V_0 \epsilon' \Delta_g {}^d \Omega_g \epsilon - V_0 \epsilon \epsilon' . ({}^d \theta_g \Delta_g + {}^l \kappa + {}^l \lambda) \right]$$

$$0 = V_0 \beta \Delta . {}^d \theta c\alpha - \tfrac{1}{2} V_0 \beta c\alpha . ({}^d \theta_g \Delta_g + {}^l \kappa + {}^l \lambda) - \tfrac{1}{2} V_0 ({}^d \theta_g \Delta_g + {}^l \kappa + {}^l \lambda) c\alpha . \beta$$

The last of these equations follows from the preceding one when it is observed that the forty scalars of $\delta E_\alpha c\beta$ are arbitrary and that from the symmetrical condition $E_\alpha' \beta = E_\beta' \alpha$ it follows that $E_\alpha c\beta$ is self-conjugate in $c\beta$. Putting (ϵ, ϵ) for $(\beta, c\alpha)$ in the last equation we obtain

$$\frac{ {}^d \theta_g \Delta_g + E_\epsilon' {}^d \theta \epsilon }{1 + n} = \frac{ {}^l \kappa + {}^l \lambda }{1 - n} \tag{16}$$

$$= \frac{ {}^d \theta_g \Delta_g + E_\epsilon' {}^d \theta \epsilon + ({}^l \kappa + {}^l \lambda) }{2}$$

Therefore

$$0 = V_0 \beta \Delta . {}^d \theta c\alpha + E_\beta' {}^d \theta c\alpha + {}^d \theta E_\beta c\alpha . - {}^d \theta c\alpha V_0 \beta E_\epsilon \epsilon + \left[V_0 \beta c\alpha . ({}^l \kappa + {}^l \lambda) + V_0 ({}^l \kappa + {}^l \lambda) c\alpha . \beta \right] / (n - 1) \tag{17}$$

In (17) put $d\theta c\alpha = \epsilon$ and operate on the equation by $V_0\epsilon(\ )$. The equation may be put in the form $V_0\beta[\ ] = 0$ where $[\ ]$ is, of course, a covari--ant vector which our principle shows to be equal to zero. We thus obtain equation (6) above. Returning to the equation from which we derived this result ex--press it in terms of θ where $d\theta = l\theta^{-1}$ as usual, and making it invariantive, we obtain (12) thus:- Equation (17) may be written $0 = d\theta_\beta c\alpha +$ terms in $(l\kappa + l\lambda)$ where the suffix β indicates absolute diff--erentiation in the E_β sense. Writing $l^{-1}(l\kappa + l\lambda)$ as $(\lambda+\kappa)$, the last equation in turn becomes

$0 = \theta_\beta\alpha +$ terms in $\theta(\lambda+\kappa)$ or in full

$$
\begin{aligned}
0 = {} & V_0\beta\Delta . \theta\alpha - E_\beta\theta\alpha - \theta E_\beta'\alpha \\
& + (1-n)^{-1}\theta[V_0\beta\theta\alpha . (\lambda+\kappa) \\
& + V_0(\lambda+\kappa)\theta\alpha . \beta \\
& + 2(2-n)^{-1}V_0\beta\theta(\lambda+\kappa) . \alpha]
\end{aligned}
$$

(The third term within the square brackets arises from $E_\epsilon\epsilon$ when we change from $d\theta_\beta$ to θ_β above). The establishment of (12) from this equation is a familiar process, and in multenions it takes the fol--lowing form. From this equation write down two other equations, the first by interchanging α and β , the second being the negative conjugate of the original with regard to β ; then add the three equations to--gether. It may be noted that (16) is a result in addition to those given in Art. 2. We may consider that we have now established all the results of Art.2 except the identity (10).

(10) is obtained by the process fully exhibited in the paper already referred to, where the identity depending on the invariants of $l^{-1}f$ was considered. Here, however, we will treat the matter much more generally. We will first consider a general theorem of the type of (10), and afterwards enunciate a still

more general theorem.

Let ^{l}x be an invariant density function of any number of covariant hyper-vectors (of which ^{c}w is taken as the type) and of any number of coexcontra multenion linities of the type ${}_{a}\xi_{b}$, which is used to denote a linity of the form $\Sigma{}^{c}u\,V_{0}{}^{c}v(\ \ )$. (As usual in multenions $u, v, w,$ stand always for hyper-vectors ${}_{n}V_{a}$, ${}_{n}V_{b}$, ${}_{n}V_{c}$ respectively). The condition that ^{l}x is an invariant density may be stated as that

$$-{}^{l}x\,V_{0}\Delta\sigma = \delta'{}^{l}x \qquad (18)$$

The σ here used is put in place of the ϵ representing an infinitesimal change of coordinates in my papers already referred to, and in the same papers δ' is explained as expressing a definite kind of increment in any symbol depending on this change. $\delta'{}^{l}x$ may be explicitly put in the form $-V_{0}\sigma_{9}{}^{l}U\Delta_{g}$ so that since all the derivatives of σ are arbitary we get the identity ${}^{l}U - {}^{l}x = 0$ or, say, ${}^{l}X = 0$ where ${}^{l}X$ stands for ${}^{l}U - {}^{l}x$. This is the necessary and sufficient condition that ^{l}x is an invariant density. (10) expresses that ${}^{l}X_{9}\Delta_{9} = 0$ In our general case we can show that the part contributed to this second identity by every individual ^{c}w and also every individual ${}_{a}\xi_{b}$ is invariantive.

There is no necessity to cumber our work with the summation sign. It is quite sufficient to speak as though there were but a single ^{c}w and a single ${}_{a}\xi_{b}$. Let ${}_{a}\xi_{b} = \xi$. Define ^{l}w and $^{d}\xi$ by the equation

$$d\,{}^{l}x = V_{0}{}^{l}w\,d{}^{c}w + V_{0}{}^{d}\xi e\,d\xi e \qquad (19)$$

We find that
$$\begin{aligned} {}^{l}X^{c}\alpha = {} & V_{1}{}^{c}w\,V_{c-1}{}^{l}w^{c}\alpha \\ & + V_{1}\xi e\,V_{a-1}{}^{d}\xi e^{c}\alpha \\ & + V_{1}\xi'{}^{d}\xi e\,V_{b-1}e^{c}\alpha \\ & - {}^{l}x^{c}\alpha \end{aligned} \qquad (20)$$

and

$$\Delta^l x = \Delta_9 V_0{}^c w_9{}^l w + \Delta_9 V_0 \xi_9 e^d \xi e \qquad (21)$$

whence

$$^l X_9 \Delta_9 = V_1{}^c w V_{c-1}{}^l w_9 \Delta_9 - V_1{}^l w V_{c+1}{}^c w_9 \Delta_9$$
$$+ \text{ terms contributed by } \xi \qquad (22)$$

Abreviate the expression on the right of (22) as follows:-

$$\{^l w, {}^c w\} = V_1(V_{c-1}\Delta^l w)^c w$$
$$- V_1(V_{c+1}\Delta^c w)^l w \qquad (23)$$

Also let

$$\xi(\ ) = \Sigma^c w V_0{}^c v(\ ) \qquad (24)$$

Then (22) may be written

$$^l X_9 \Delta_9 = \{^l w, {}^c w\} + \Sigma\{^d \xi^c v, {}^c w\}$$
$$+ \Sigma\{^d \xi'^c w, {}^c v\} \qquad (25)$$

which is obviously a covariant vector density.

We will now in Art. 4. indicate the proof of these assertions, and ennunciate the more general theorem mentioned above.

Art. 4. A general theorem in identities.

In different parts of my papers (2) already referred the following has been shown. Let ρ become $\rho + \sigma$ by infinitesimal change of coordinates. The increment $\delta'\alpha$ in a contravariant vector α will then be

$$\delta'\alpha = V_0 \alpha \Delta . \sigma = \chi_0 \alpha \qquad (26)$$

If now q, ${}^c q$ are a contravariant and covariant mul--tenion respectively

$$\delta' q = \chi_0 q, \quad \delta'{}^c q = -\chi_0'{}^c q \qquad (27)$$

To express these explicitly in terms of σ put

$$q = \Sigma w, \quad {}^c q = \Sigma\, {}^c w \tag{28}$$

where the summation sign implies that the homogeneity c of w and of ${}^c w$ takes all intergral values from 0 to n. Then

$$\left.\begin{aligned} X_0 q &= \Sigma V_c X_0 \epsilon V_{c-1} \epsilon w \\ &\doteq \Sigma V_c \sigma_9 V_{c-1} \Delta_9 w, \\ -X_0'{}^c q &= -\Sigma V_c \Delta_9 V_{c-1} \sigma_9 {}^c w \end{aligned}\right\} \tag{29}$$

With this help the reader should find no difficulty.

The more general theorem is as follows. Let an invariantive multenion here mean $q f({}^l k)$, where q is any covariant or contravariant multenion and $f({}^l k)$ is any scalar function of any scalar density ${}^l k$. Similarly an invariantive multenion linity means $\phi . F({}^l k)$ where ϕ is any coexcontra, contraexco, coexco or contraexcontra, linity; and $F({}^l k)$ any scalar function of ${}^l k$. Let ${}^l x$ be any given function of any number of such invariantive multenions and multenion linities, and let ${}^l X$, a covariant vector linity density, be formed from it exactly as in Art. 3. Then, as in Art. 3, ${}^l X = 0$ and ${}^l X_9 \Delta_9 = 0$ and the expression ${}^l X_9 \Delta_9$ consists of a sum of invariantive parts contributed by the individ--ual multenions and multenion linities. Each of these parts in turn subdivides into two invariantive parts, contractile and non-contractile, whose treatment however is reserved for a later paper.

It may be suggested to the reader that to prove this more general form attention should first be paid to the separate part contributed by ${}^l k$, which will be found to be of the form ${}^l k \Delta$ (invariant).

It is interesting to observe that the invariantive expressions above are quite independent of the exist--ence of a fundamental differential quadratic form.

Art. 5. Some reforms in notation.

When first in 1907 treating of multenions I express-ed a doubt whether the sign of Hamilton's ∇ should be taken over from quaternions into multenions. To-day I am certain that it should not have been. As the present series of papers affords a suitable opp-ortunity to make some very desirable changes of notation, for all time, I will not apologise for causing the reader some little inconvenience by so doing.

Thus is caused the change expressed by $\Delta = -\nabla$, (Art. 2. above), and the allied change $(\epsilon\epsilon) = -(\zeta\zeta)$; and (ee) is a natural addendum to $(\epsilon\epsilon)$

Formally we have

$$(\epsilon\epsilon) = \Sigma(\iota_\alpha, \iota_\alpha^{-1}), \quad , \quad = \Sigma(\overset{c}{\iota}, \overset{c}{\iota}^{-1}) \qquad (30)$$

where ι_1, ι_2, ... , ι_n are the n primitive unit vectors and $\overset{c}{\iota}$ is one of the 2^n primitive unit vect-oriums. ${}_q\Delta$ stands to q as does Δ to ρ, that is to say, if $q = \Sigma x\overset{c}{\iota}$, then ${}_q\Delta = \Sigma\overset{c}{\iota}^{-1}\partial/\partial x$. With these meanings we have

$$\left.\begin{aligned} \sigma &= \epsilon V_0\epsilon\sigma, \quad q = eV_0eq, \\ d. &= V_0 d\rho\Delta., \quad d. = V_0 dq\,{}_q\Delta. \end{aligned}\right\} \qquad (31)$$

which shows that the inconvenient minus sign has, by our new conventions, been banished from many express-ions.

Our former p and $q^\times$, that is our present p and ${}^cq$, are complementary in an invariant sense, in that $V_0 p\,{}^cq$ is an invariant whatever be the values of p and ${}^cq$. Similarly our former ϕ and $\psi^\times$, that is our present ϕ and ${}^c\psi$, are complementary in that $V_0\phi e\,{}^c\psi e$ is an invariant whatever be the values of ϕ and ${}^c\psi$.

In my former paper we had X and $Y^\times$, or say X and ${}^cY$, with a similar complementary relation name-

-ly, $V_0 X e {}^c Y e$ is an invariant. As this use of ${}^c Y$ is not absolutely required, we will abandon it for simplicity of notation.

If X is a coexco linity then X' is a contraex- -contra. The dash here used may be made to supply our old use of $Y^{\times}$ thus: X shall always mean a coexco, and Y' a contraexcontra. This explains how, in Art. 2, we came to denote our old E_β by E_β' and consequently to denote old Γ_β, F_β, Θ_β, Ω, by the same letters each with a dash.

When in our present subject we have, which is by no means always the case, a fundamental quadratic form $V_0 d\rho \vartheta d\rho$ then we take $|\theta^{\frac{1}{2}}| = l$ to be a funda- -mental scalar invariant density, and we generally re- -gard any other density as obtained by multiplying a previously defined symbol by l. Hence our use of ${}^l q$, ${}^l \xi$, etc. (our former $q^{\cdot}$, $\xi^{\cdot}$, etc.) for such densities. In our use of ${}^d\Omega$, ${}^d\xi$, for our former $\Omega^{\times\cdot}$; $\xi^{\times\cdot}$, the d in the pre-index position is suppos- -ed in form a combination of the c and l that were also used in that position.

Art. 6. The origin of the present researches.

The series of researches in relativity, of which the present paper is the first, began in December 1921 with a paper sent to the Phil. Mag. correcting an error in Professor Eddington's paper "Relativity of Field and Matter" in the Phil. Mag. of Nov. 1921. In my paper was a first intimation of the importance of consider- -ing intrinsic bulk as we do above. Professor Edding- -ton later found his error and corrected it before my communication could have reached England, and no notice whatever was taken of my communication. In Jan. 1922 I sent a rather long paper suggested by the December communication to the Phil. Mag. This was entitled "A New Identity Affecting Questions on Relativity; and Some Cognate Matters." The new identity occupied but a small portion of the paper at the beginning. In the Phil. Mag. of Aug. 1922 I was surprised to find this

new identity (in a less general form) credited to Mr. Harward, who dates his communication May 1922. In September 1922 I wrote a letter, intended for publi--cation, pointing out this editorial oversight. In the Phil. Mag. for July 1923, p. 153, an editorial footnote promises that the paper whose title is given above will "appear shortly", and now in April 1924 I continue to take for granted that the paper and the letter will "appear shortly".

In November and December 1922 I sent to the Roy. Soc. Lond. three papers and a single summary of the three. The first of these appeared in the Phil. Mag. of July 1923. The summary, with the exception of two concluding sentences referring to this first paper, is as follows.

"(1) The Mechanical Forces Indicated by Relativity in an Electromagnetic Field. Can their Existence be Demonstrated?

"(2) Relativity and Elasticity.

"(3) Entropy, Conduction of Heat, Viscosity and Electric Resistance Treated on the Principles of Rel--ativity.

"The papers are concerned with bringing all the fun--damental equations of the physics of matter in bulk under the domain of relativity. A paper by the author On the Mathematical Theory of Electromagnetism (Phil. Trans.) in the year 1893 had, in pre-relativity days, made a comprehensive survey of like general kind. In addition to electromagnetism the foundations of all the subjects in our present titles are reviewed. With--out exception and also without any loss of generality it has been shown in our present three papers that all the features of the 1893 paper can be copied into the relativity scheme. The results are surprising in that, so far from introducing complications into these phys--ical foundations as probably all relativists antici--pated, relativity introduces great and important simplification."

It was officially communicated to me that the ref--eree reported that these papers "cannot possibly be printed" for one and only one reason, which was worded thus:-

"You use quaternions."

The reason was expanded into the assertion that it was as inappropriate to "use quaternions" as it would be to address an English scientific audience in Sans--krit. Doubtless a copy of this curious communication has been kept by the Secretaries of the Royal Society and can be seen by any F.R.S. who cares to verify that this is an exact account of the matter.

The researches on quanta sent to "Nature" in May 1923 have been mentioned above.

It is therefore necessary to bring out these resear--ches in distant Tasmania. The whim of a gentleman who dislikes quaternions has ruled that for this de--cade at any rate that subject is verboten in London. It should be clear that one of my main objects has been to show from the fruits of the method that it is much more efficient that the current method of tensors in surmounting the formidable difficulties that rela--tivity presents to the pioneer.

The present series of papers will deal with the subjects mentioned in this article and some two other researches already in existence; but they need to be revised because the present paper has co-ordinated the previously independent elements in the basis of relativity into a consistent whole, the bearing of which on these questions remains to be looked into. (The original papers will be placed in custody of the Roy. Soc. Tas.)

Mathematicians generally should be grateful to the Royal Society of Tasmania for finding means fot the publication of these papers, in spite of the fact that the funds of the society are urgently needed in other scientific directions. Not all readers may realise that the population of Tasmania, the sole support of

this Society, is considerably less than that of Cornwall, or about the same as that of Dorset. It is not usual to expect a community of that size to have the facilities for printing technical mathematics. Our difficulties in this matter of printing or some alternative method of reproduction are proving great. But for the very friendly interest taken by all the printing establishments in Hobart, and the great amount of trouble that the Government Statistician, Major L.F.Giblin, D.S.O., has taken upon himself in making enquiries as to methods and processes, the work could scarcely have been undertaken. My best thanks are also due to Mr. R.G.L. Brett who has given much of his time in the laborious work of drafting the formulae for reproduction.

References.

(1) "Multenions and Differential Invariants, I., II, III." Proc. R.S. Lond. A; Vol. 99, 1921, p.292; Vol. 102, 1922, p. 210; Vol. 103, 1923, p. 162. For the future these papers will be referred to as M.D.I. (I), (II), (III). The present paper may be taken to supersede M.D.I. (III) Art. 21.

(2) M.D.I. (II) Art. 18, p. 235 (bottom of); M.D.I. (II) Art. 15; M.D.I. (I) Art. 6 (part added Feb. 1921) eq. 11.

Year of Election.

1924 Shoobridge, Rupert. "Fenton Forest," Glenora.
1923 Shoobridge, S. E. C/o Messrs. H. Jones and Co., Hobart.
1923 Simson, Mrs. L. 3 St. George's Square, Launceston.
1917 Slaytor, C. H. Misterton, Doncaster, England.
1924 Smith, Colonel R. P. A.M.P. Society, Hobart.
1921 Smithies, F. 34 Patterson Street, Launceston.
1924 Stephens, Crofton. Messrs. Clerk, Walker, Stops, and Stephens, Collins Street.
1919 Stevenson, Miss F. "Leith House," New Town.
1920 Swindells, A. W. 2 Patrick Street, Hobart.
1907 Tarleton, J. W. Regent Street, Sandy Bay.
1918 Taylor, W. E. Elboden Street, Hobart.
1920 Taylour, Harold. Equitable Buildings, Collins Street, Melbourne.
1920 Taylour, W. H. Equitable Buildings, Collins Street, Melbourne.
1923 Thomas, J. F. 64 Elizabeth Street, Sydney.
1922 Thomas, Lieut.-Col. L. R., D.S.O. The University, Hobart.
1921 Thomas, P. H. Agricultural Department, Hobart.
1922 Thomson, E. H. Lower Sandy Bay.
1918 Thorold, C. C. Hutchins School, Hobart.
1921 Tymms, Dr. A. O. 18 York Street, Launceston.
1923 Unwin, E. E., M.Sc. Pendle Hill, Mortimer Avenue.
1918 Walch, P. B. C. King Street, Sandy Bay.
1913 Wardman, John. Botanical Gardens, Hobart.
1918 Waterhouse, G. W. Messrs. Ritchie and Parker, Alfred Green and Co., Launceston.
1922 Waterworth, E. N. Poet's Road, West Hobart.
1922 Watson, D. W. "Undine," Glenorchy.
1922 Wayn, Miss A. L. Lambert Avenue, Sandy Bay.
1918 Weber, A. F. Lands Department.
1923 Webster, Hugh C. "Greystanes," Lower Sandy Bay.
1923 Wherrett, Miss A. Florence Street, Moonah.
1922 Winch, A. A. Huon Road.
1901 Wise, H. J. Lambert Avenue, Sandy Bay.
1921 Wright, W. Invermay State School, Launceston.
1924 Young, F. M., B.A. New Town.

ANNUAL REPORT

1924

The Council and Officers.

The Annual Meeting was held at the Society's Rooms, Tasmanian Museum, on 7th March, 1924.

The following members were elected as members of the Council for 1924:—Messrs. W. H. Clemes, W. H. Cummins, Dr. W. L. Crowther, Major L. F. Giblin, Rt. Rev. Dr. R. S. Hay, Messrs. J. A. Johnson, J. Moore-Robinson, L. Rodway, and Dr. Sprott.

During the year eight meetings of the Council were held, and the attendance was as follows:—Mr. Rodway, 8; Mr. Lord, 8; Mr. Johnson, 7; Major Giblin, 6; Mr. Clemes, 6; Dr. Crowther, 6; Dr. Sprott, 5; Mr. Cummins, 4; Rt. Rev. R. S. Hay, 3 (on leave of absence for part of the year); Mr. J. Moore-Robinson, 3.

The Council at its first meeting made the following appointments:—

Chairman of Council:—Mr. L. Rodway, C.M.G.

Standing Committee:—Messrs. L. Rodway, Clemes, and Major Giblin.

Editor of Papers and Proceedings:—Mr. Clive Lord.

Honorary Treasurer:—Mr. J. Moore-Robinson.

Trustees of the Tasmanian Museum and Botanical Gardens:—Doctors Crowther and Sprott, Messrs. Clemes, Cummins, Johnson, and Rodway.

Meetings.

During the year ten ordinary meetings and one special meeting of the Society were held, and were well attended. Details concerning same will be found in the Abstract of Proceedings.

Membership.

The membership of the Society continues to be satisfactory, the roll at the end of the year showed 3 Honorary Members, 10 Corresponding Members, 9 Life Members, and 250 Ordinary Members.

Finance.

The financial position was again a matter of concern to the Council, the cost of printing the Papers and Proceedings being a very severe strain on the Society's resources.

In order to publish certain important papers written by Professor McAulay on Relativity a special fund was opened and very generous response was made by members and others interested. This accounts for the credit balance being shown on the annual statement of accounts, but as only a portion of the Papers have been published, the fund has not been drawn on to its full extent. Owing to the financial situation the Government reduced their contribution towards the cost of printing the Papers and Proceedings from £100 to £83 6s. 8d., which reduction caused the Council some concern, but it is satisfactory to know that the full amount of £100 will be available next year as the Government, recognising the good work which the Society is doing, has agreed to restore the vote to the original amount.

Franklin Papers.

A very valuable addition to the Society's Library was made during the year, Mr. W. F. Rawnsley presenting to the Society, through the Agent-General for Tasmania, a most valuable collection of Franklin MSS. Included in the collection are several diaries written by Lady Franklin during excursions made to different places in Tasmania. The thanks of the Society are due to Mr. Rawnsley and to Sir A. H. Ashbolt in connection with this matter.

Library.

Under the Royal Society Act the Society is entitled to sufficient room in the Museum Buildings for the storage of its library, etc. At the present time the Library is over-

crowded to such an extent that it is not possible to continue the correct classification of the various works. The Library now contains over 14,000 volumes, and is the outstanding Library of its class in the State. Apart from the members of the Society, Government Departments and others find the Library of very considerable benefit, as applications for reference, etc., are continually being received by the Society. The Council approached the Trustees of the Museum in regard to the matter, but the Trustees replied to the effect that the accommodation in the Museum itself was already overtaxed and it would be impossible to grant any further space until certain additions were made to the Museum Buildings. The Government has been approached in regard to the matter, and, although unable to carry out the work immediately, has given some hope of an additional store being provided next year. The erection of such a store will permit the Trustees of the Museum to grant to the Society sufficient room for the storage of its Library, a right which is provided by Act of Parliament. Recognising the difficulties of the Museum Trustees the Council refrained from insisting upon its full rights until absolutely compelled to do so owing to the overcrowded state of the Library.

R. M. Johnston Memorial.

The next R. M. Johnston Memorial Lecture will be delivered in 1925, Professor Frederick Wood-Jones, D.Sc., of Adelaide University, being the R. M. Johnston Memorial Medallist and Lecturer elect.

Tasman Memorial.

In accordance with the resolutions passed last year the wording of the inscription on the Tasman Memorial is to be altered from "at this spot" to "near this spot." A detailed account of the Tasman Memorial Fund is included in the Statement of Accounts.

Obituary.

It is with regret that the Society has to record the death of the following members during the year:—Canon G. W. Shoobridge and Mr. W. H. Pearson.

R. M. JOHNSTON MEMORIAL.

THE R. M. JOHNSTON MEMORIAL MEDAL.

List of Awards:

1923, Sir T. W. Edgeworth David, K.B.E., C.M.G., B.A., F.R.S., F.G.S.

BRANCH REPORTS

NORTHERN BRANCH.

ANNUAL REPORT FOR THE YEAR 1924.

The financial unrest and social disturbance which still exist in Tasmania, in common with all other States of the Commonwealth, must, of course, react upon the scientific work of the country, and it is most satisfactory to be able to report a steady progress in face of so many disabilities, in place of a retardation of energy which might naturally be expected.

Our Membership has slightly increased, and we have now 67 members on the roll, and the average attendance at the monthly meetings continues to be fairly constant. The natural nervousness, or apathy, or lack of energy which prevents the great majority of members from submitting papers for the edification of their fellows, still forms a marked feature of the Northern branch, but is being slowly overcome, and the papers read and lectures delivered during the year are quite up to the general average.

The following is a list of the work done, and the names of the workers:—

31st March.—Annual Meeting. The following members were elected officers for the year:—President, The Hon. Tasman Shields, M.L.C. Members of Committee, H. H. Scott, J. E. Heritage, R. O. M. Miller, B.A., F. Smithies, J. R. Forward, W. D. Reid, and F. J. Heyward. Hon. Secretary and Treasurer, G. H. Halligan, F.G.S.

At the conclusion of the formal business Mr. H. H. Scott delivered a lecture on "The evolution of animal forms," illustrated by lantern views.

5th May.—Mr. D. V. Allen, B.Sc., read a paper on "Coal, its occurrence and exploitation."

30th May.—Professor A. H. S. Lucas, M.A., delivered a lecture on "Seaweeds" with special reference to those found on the Tasmanian Coast.

6th June.—Mr. M. S. R. Sharland, R.A.O.U., delivered a lecture on "Nomadic and Internal Migration of Birds," illustrated by lantern views.

21st July.—Mr. H. H. Scott and Dr. R. McClinton, D.D.S., conjointly read a paper "Some notes and radiographs of a Tasmanian Aboriginal Skull," illustrated by lantern views.

Mr. G. H. Halligan, F.G.S., and Mr. H. H. Scott read a paper entitled "Notes on some remarkable instances of adaptation to environment of certain plants," also illustrated by lantern views.

5th August.—Exhibit evening. Mr. H. H. Scott showed some microscopic slides illustrating the life history of some Tasmanian ferns, as well as some of the radiolaria and flobigerina ooze, and other foraminifers collected during the voyage of the *Challenger*. Mr. R. S. Padman exhibited and described the mechanism and the uses of various optical instruments in use by present-day opticians.

Brigadier-General W. Martin exhibited a copy of a "Licence" or "Issue of March" of the time of King George III., by which a certain Merchant was authorised to prey upon enemies, at that time the ships of the United States of America. Accompanying the "Licence" was an agreement appoining the shares of the plunder to be received by the ship's owners and company.

Mr. Symmonds, of the H. and S. Electric Company, exhibited a four-valve radio set made especially for the reception of gramophone records, but owning to the "Launceston roar" no messages could be satisfactorily identified.

Mr. G. H. Halligan, F.G.S., exhibited about 50 samples of sand collected from the sea-shore around Australia and the East Indies, and explained the significance of the almost pure silicious and the foraminiferous sand found in different localities. He also showed curious fish-hooks used at the Pacific atolls, shark's eggs, nuts of the Egyptian Doum palm, Ivory nuts, etc.

Mr. J. E. Heritage exhibited some aboriginal chipped instruments and weapons and spoke of their uses and probable origin.

Mr. W. P. Hales, M. Inst. C.E., exhibited a map of Tasmania drawn in 1839 showing some features not now existing.

23rd November.—Discussion on "The alleged injury to the Tamar River fishing industry by seals." Representatives of the Australian Natives' Association and the Northern Tasmanian Fishing Association were present by invitation and contributed to the discussion.

REPORTS OF SECTIONS

HISTORICAL AND GEOGRAPHICAL SECTION.

The Annual Meeting of the Historical and Geographical section was held on the 29th May. Mr. W. F. D. Butler was re-elected to the position of chairman, and Mr. J. Reynolds to the position of Hon. Secretary. At the conclusion of the business the members present availed themselves of the opportunity of examining several of Lady Franklin's letters, which recently came into the possession of the Society. It was decided to prepare an evening for a future Royal Society's meeting from the matter contained in the letters describing the trip to Recherche Bay in 1839.

It was also suggested that the trustees of the Tasmanian Museum be approached and asked to consider the advisability of naming the present Tasmania room of that institution "The Franklin Room." The section considered that the services which Sir John Franklin and his wife rendered the Museum should be recognised in this manner.

The second meeting of the section was held on 24th July. The location and appropriately marking of the spot of Collins's landing at Sullivan's Cove (1804) was considered by the meeting most necessary. Mr. Clive Lord undertook to make preliminary inquiries and report to a later meeting. The method of celebrating the centenary of constitutional independence of Tasmania, which will be completed on 3rd December, 1925, was fully discussed. A sub-committee consisting of Messrs. W. F. D. Butler (chairman), A. W. Courtney-Pratt, Dr. W. L. Crowther, and the Hon. Secretary were appointed to draw up a preliminary report.

The third meeting, 23rd October, unfortunately lapsed as it clashed with several other functions.

The report of the Centenary sub-committee was received at an informal meeting of the section on 17th December. This meeting resolved itself into a committee to deal with the centenary celebrations along the lines suggested in the sub-committee's report. Mr. Clive Lord was unanimously elected Hon. Organising Secretary of the historical exhibition

which it is proposed to hold in Hobart early in December, 1925. Mr. J. Reynolds was appointed Recording Secretary. It was decided to meet early in 1925.

The Historical and Geographical Section makes a very urgent appeal to the public and particularly to the members of the Royal Society for their co-operation in order to make the exhibition worthy of the State. Persons in the possession of letters, documents, prints, pictures, etc., which were written in the early days of the Settlement are particularly required. Any other articles of now historical interest which were brought to the State or manufactured prior to 1850 are also wanted. Persons lending such articles will be given the utmost guarantee of security possible.

EDUCATION SECTION.

Chairman: Mr. T. W. Blaikie.

Secretary: Mr. H. T. Parker.

The following meetings were held:—

19th May.—The Differentiation of the Sexes in the Curricula of Secondary Schools. Major L. F. Giblin.

17th June.—The Dalcroze School of Eurythmics. Mr. L. Dechaineux.

15th July.—Differentiation. Mr. T. W. Blaikie. The Dalton Plan. Mr. J. A. Johnson. The Project Method. Mr. G. H. Huxley.

19th August.—New Methods of Examination. Mr. G. A. Purcell, Mr. H. T. Parker.

16th September.—The Play Way; The Perse School. Mr. W. H. Clemes.

21st October.—Sanderson of Oundle. Mr. E. E. Unwin.

ROYAL SOCIETY OF TASMANIA.

RECEIPTS AND EXPENDITURE, 1924. GENERAL FUND.

RECEIPTS.

	£	s.	d.
Balance brought forward	0	16	1
Government Grant	83	6	8
Subscriptions, etc.	221	11	6
Rent of Room	10	0	0
Donations to McAulay Fund	61	3	3
	£376	17	6

EXPENDITURE.

	£	s.	d.	£	s.	d.
Salaries				40	7	0
Papers and Proceedings:—						
1923 (Part)	129	19	1			
1924 (Part)	67	7	8			
				197	6	9
Meetings, etc.				39	0	3
Library				22	6	6
Light and Fuel				2	15	2
Lantern				1	1	0
Petty Cash and Postages				7	10	9
Northern Branch				12	12	0
Miscellaneous				29	1	0
Cheque Book				0	5	0
Advance to M.A.M. Fund				1	19	0
Balance carried forward				22	13	1
				£376	17	6

I have compared the Receipt Book, Vouchers, and Bank Book with items particularised in the Cash Book and found them to be correct.

R. A. BLACK,
Hon. Auditor.

27/1/25.

J. MOORE-ROBINSON,
Hon. Treasurer.
CLIVE LORD,
Secretary.

MORTON ALLPORT MEMORIAL FUND, 1924.

RECEIPTS.	£	s.	d.	PAYMENTS.	£	s.	d.
Brought forward	3	18	0	Part cost Mathews's "Birds of Australia"	15	12	0
Revenue, 1924	9	15	0				
Loan from General Fund	1	19	0				
	£15	12	0		£15	12	0

I have compared the Receipt Book, Vouchers, and Bank Book with items particularised in the Cash Book and found them to be correct.

R. A. BLACK,
Hon. Auditor.

27/1/25.

J. MOORE-ROBINSON,
Hon. Treasurer.
CLIVE LORD.
Secretary.

R. M. JOHNSTON MEMORIAL FUND, 1924.

RECEIPTS.	£	s.	d.	PAYMENTS.	£	s.	d.
Brought forward	1	10	10	Credit Balance	16	2	10
Revenue, 1924	14	12	0				
	£16	2	10		£16	2	10

I have compared the Receipt Book, Vouchers, and Bank Book with items particularised in the Cash Book and found them to be correct.

R. A. BLACK,
Hon. Auditor.

27/1/25.

J. MOORE-ROBINSON,
Hon. Treasurer,
CLIVE LORD,
Secretary.

NORTHERN BRANCH.

ANNUAL FINANCIAL STATEMENT FOR THE YEAR ENDING 31st DECEMBER, 1924.

	£	s.	d.		£	s.	d.
Balance on 31st December, 1923	21	0	1	Printing and Advertising	10	18	0
Interest	0	14	5	Stamps	1	16	2
Share of Subscriptions	12	12	0	Stationery	0	4	6
				Office Sundries	0	4	6
				Travelling Expenses	2	15	0
				Exchange	0	0	3
				Balance	18	8	1
	£34	6	6		£34	6	6

Compiled from the books and accounts of the Royal Society of Tasmania, Northern Branch, and certified to be in accordance herewith.

J. E. HERITAGE,
Hon. Auditor.

GERALD H. HALLIGAN,
Hon. Treasurer.

TASMAN MEMORIAL FUND.

FINAL FINANCIAL STATEMENT—17th JANUARY, 1925.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
By Subscriptions	65	6	0	Accounts—			
Interest Hobart Savings Bank	0	10	3	Drysdale and Walpole	2	2	10
				E. O. Coyle	0	16	0
				A. E. Willing	9	13	8
				A. E. Willing	0	10	10
				F. W. Heritage	9	3	4
				Cane and Co.	2	2	0
				George Long	7	2	3
				Chas. Davis	0	2	0
				W. A. Belcher	1	2	0
				Hydro-Electric Dept. (lost material)	1	2	6
				Wages (men employed at erection)	30	9	6
				Cash in hand	1	9	4
	£65	16	3		£65	16	3

I hereby certify that I have examined the Receipts and Vouchers handed to me by the Hon. Treasurer and have compared them with the statement as shown above and am of the opinion that it presents a true record of the transactions referred to therein.

(Signed) R. A. BLACK,
Hon. Auditor.

27/1/25.

(Signed) J. MOORE-ROBINSON.
Hon. Treasurer.

17th January, 1925.

INDEX

Titles of Papers, and New Genera and Species (sp. nov.) in **Heavy Type.**

THE ROYAL SOCIETY
OF
TASMANIA

A

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1925

(With 24 Plates and 36 Text Figures)

ISSUED 5th MARCH, 1926

PUBLISHED BY THE SOCIETY

The Tasmanian Museum, Argyle Street, Hobart
1926

Price : Ten Shillings

The responsibility of the statements and opinions in the following papers and discussions rests with the individual authors and speakers; the Society merely places them on record.

THE ROYAL SOCIETY OF TASMANIA

The Royal Society of Tasmania was founded on the 14th October, 1843, by His Excellency Sir John Eardley Eardley Wilmot, Lieutenant Governor of Van Diemen's Land, as "The Botanical and Horticultural Society of Van Diemen's Land." The Botanical Gardens in the Queen's Domain, near Hobart, were shortly afterwards placed under its management, and a grant of £400 a year towards their maintenance was made by the Government. In 1844, His Excellency announced to the Society that Her Majesty the Queen had signified her consent to become its patron; and that its designation should thenceforward be "The Royal Society of Van Diemen's Land for Horticulture, Botany, and the Advancement of Science."

In 1848 the Society established the Tasmanian Museum; and in 1849 it commenced the publication of its "Papers and Proceedings."

In 1854 the Legislative Council of Tasmania by "The Royal Society Act" made provision for vesting the property of the Society in trustees, and for other matters connected with the management of its affairs.

In 1855 the name of the Colony was changed to Tasmania, and the Society then became "The Royal Society of Tasmania for Horticulture, Botany, and the Advancement of Science."

In 1860 a piece of ground at the corner of Argyle and Macquarie streets, Hobart, was given by the Crown to the Society as a site for a Museum, and a grant of £3,000 was made for the erection of a building. The Society contributed £1,800 towards the cost, and the new Museum was finished in 1862.

In 1885 the Society gave back to the Crown the Botanical Gardens and the Museum, which, with the collections of the Museum, were vested in a body of trustees, of whom six are chosen from the Society. In consideration of the services it had rendered in the promotion of science, and in the formation and management of the Museum and Gardens, the right was reserved to the Society to have exclusive possession of sufficient and convenient rooms in the Museum, for the safe custody of its Library, and for its meetings, and for all other purposes connected with it.

In 1911 the Parliament of Tasmania, by "The Royal Society Act, 1911," created the Society a body corporate by the name of "The Royal Society of Tasmania," with perpetual succession.

The object of the Society is declared by its Rules to be "the advancement of knowledge."

His Majesty the King is Patron of the Society; and His Excellency the Governor of Tasmania is President.

THE ROYAL SOCIETY OF TASMANIA

PAPERS AND PROCEEDINGS, 1925

CONTENTS

PAPERS

OF

THE ROYAL SOCIETY OF TASMANIA

1925

TASMANIAN GIANT MARSUPIALS

By

H. H. SCOTT, Curator of Launceston Museum,

and

CLIVE E. LORD, F.L.S., Director of the Tasmanian Museum, Hobart.

(Read 9th March, 1925.)

In the years 1870 to 1884 Professor O. C. Marsh created a new Order for the reception of certain fossil mammalian remains, which he designated (Marsh, 1884) *Dinocerata*. This Order included the extinct creatures now called *Titanotherium robustum* and *Tinoceras ingens*, as well as others that need not here detain us. The sifting processes of modern taxonomy have necessitated the removal of the two creatures named, and their separation into distinct Sub-orders (of the Order *Ungulata*) namely:—

Sub-order *Titanotheriidæ*, of which *Titanotherium robustum* is typical, and Sub-order *Amblypoda*, which not only contains *Tinoceras ingens*, but also the European extinct ungulates known as *Coryphodon* and their American allies. Tentatively, *Arsinoitherium*, which is now removed to another Sub-order (*Embrithopoda*), also found a resting place here. Leaving out the last-named animal, it will be obvious that Marsh's Order of *Dinocerata* covered a wide area, and included within its circumference animals more or less Rhinoceros-like, and some, that while armed with fighting bosses, upon their skulls, did not closely simulate the make-up of a modern Rhinoceros. Strictly speaking, neither *Titanotherium*, which is the most Rhinoceros-like of the group, nor

Tinoceras ingens, which is nose armed with bony bosses, was a Rhinoceros in the modern sense of the term. Indeed, as far back as 1876 Professor R. Owen expressed (Owen, 1876) his doubts as to the nature of the nasal weapons with which the *Dinocerata* were armed, and suggested that the absence of vascular grooves from the bony bosses indicated that they did not simulate the horns of the Ruminants. Professor Marsh, in his Monograph upon the *Dinocerata* (Marsh, 1884, pp. 167-168), refers to this question, and suggests that hard pads of skin may have covered the bosses, or that even horns similar to those of the American Antelope may have been present, since in that animal (*Antilocapra*) the horn cores were smoother than those of the *Dinocerata*. This lengthy introduction is essential to a clear understanding of what we have said of the parallel evolution in Australia of Marsupials that were nasally armed. Such paralleled items chiefly relating to the modifications of the anterior part of the skeleton, as the Giant Marsupials evolved their fighting weapons. As these weapons, we think, were more like those of the modern perissodactylan Rhinoceroses than those of *Titanotherium* or *Tinoceras*, we used, as a vernacular name, for the nasally armed marsupials that of "Marsupial Rhinoceroses," a term that has apparently called out so much protest that it is worth while to review the actual evidence.

The first point to stress is *that vascular grooves exist in the areas of the skulls of the giant marsupials, which are without any great elevations, such as obtain in either Titanotherium or Tinoceras.*

Secondly, the areas covered by these fighting weapons in the *Nototheria* were of considerable size, suggesting some such weapon as that of a modern Rhinoceros, and one that was nourished from various parts of that basal area, and evolved out of the hairy dermal covering. That its base may have been transitional between true skin and agglutinated hair, and its upward extension directly derived from the hair, as in a modern Rhinoceros, seemed to us as likely as not; accordingly, we wrote in terms of that assumption. Upon the broad points of anatomy, a *Nototherium* was much nearer to *Tinoceras* than to *Titanotherium*, but all attempts at comparison between a giant marsupial and any of the *Dinocerata*, as Marsh called them, must end when we come to the feet, since the marsupial manus and pes stand unique.

Our publications on this subject have all been intended to show that any race of animals that begins to acquire

nasal armament will, more or less, follow the main lines set by the *Dinocerata* and the Rhinoceroses, since these practically cover the whole field of possibilities, and we have cited the several approaches and departures to and from the animals named as we noted them, regardless of man-made taxonomy. Further, the place which the *Nototheria* occupied in the faunal list of Australia was similar to that which the *Dinocerata* (to again use the widely covering term of Marsh) held in the American faunal list, and in habits they had as much in common as the Dasyures of Australia have with the Martens and Genets of other lands.

In the American Eocene Animals cited the acquisition of fighting weapons was gradual, as it was with the Australian Marsupial Nototheres, and we are busy trying to piece together the several sequences. As we stated (Scott and Lord, 1920, p. 76) in August, 1920, "A wonderful and most inter-"esting group of marsupial animals has died out in our "immediate zoological province, and as the remains available "to us are superior in point of preservation to anything "obtained in other parts of Australia, we are tempted to pay "more attention to phyletic than to taxonomic data."

Recognising the need for considerable research with regard to this interesting group before many matters can be treated in detail, we have preferred to treat the subject in a general manner rather than to enter into details of classification, etc. To such criticism as the above course has brought forth we offer the following remarks:—

1. The *Nototheria* were arising out of a Teleocerine into a more perfectly armed state, and that arming was apparently being derived from skin and hair, rather than from true horn—itself an epidermal derivative.

2. The anterior parts of their skeletons were being changed to meet these progressive alterations, and we are at work upon all such data as the fossil remains come to us from our ancient lake beds.

3. We assumed that a nasally armed marsupial was better understood by the public generally in terms of the Greek designation Rhino-keras—or its accepted rendition, Rhinoceros—than it would have been had we turned it into Latin and named a Nototherium—A Nasocornuted Marsupial.

Museum Curators who have to meet inquiry from the leisurely dilettante, the specialist, and the man of the street, are apt to use terms that are self-descriptive. In our

case we were brought face to face with a new setting of an old problem in regard to Australian Marsupials, which in essence was as follows:—The teaching had been strongly instilled into the public mind that our Marsupials were a race of non-combative creatures, and that even the extinct giants were perfectly harmless animals. The voice of the one old Prophet who had chanted to the opposite tune had been drowned by the opposition's clamour. When we found that the titanic marsupials that came our way were (to use our much abused term) starting a "fighting trend," and even manifesting stages of advancement thereon, we said so—and used such terms as we considered best illustrated the facts. The average man when told, as our Museum cards do tell, that these marsupials were more or less Rhinoceroses in the making—and when he sees for himself that the heavier the nasal weapon the more the skeleton is altered to meet the new conditions—is able to get some sort of a mental picture to work upon, and he is not likely to bother if the selected name be a marsupial-like Rhinoceros, or a nose-horned marsupial.

We would remind the critics of our vernacular designations that they have overlooked one salient fact, namely, that the pacific or aggressive nature of the larger marsupials was the item awaiting solution at the time we started, and not any one—or all—minor details of classification. The latter can be settled once and for all, when we know the animals by complete skeletons, and not by deductions made from skeletons slowly and painfully put together from scattered and quite unserial bones and teeth.

The small amount that we have been able to do has been enough to show us how great is the unknown, and so we assume that the sun has not yet risen upon the day of taxonomic minutiæ, and we are acting accordingly.

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1884 Marsh, O. C. Dinocerata. A Monograph of an Extinct Order of Gigantic Mammals. U.S. Geological Survey, 1884.

1876 Owen, R. On the existence or not of horns in the Dinocerata. Amr. Jour. Science & Act., Vol. XI., pp. 401-403, 1876.

1920 Scott and Lord. Studies in Tasmanian Mammals, living and extinct. Proc. Roy. Soc. Tas., August, 1920, page 76.

SOME NOTES UPON A TASMANIAN ABORIGINAL SKULL.

By

H. H. SCOTT, Curator of the Launceston Museum,

and

R. McCLINTON, D.D.S. (Cal.).

Plates I.-VIII.

(Read 9th March, 1925.)

The Skull, which has recently come to light, was discovered upon the North-East Coast, and apparently represents the total "find," since extended search failed to add other remains.

It is devoid of a mandible, but otherwise is extremely perfect, even the turbinoid bones being *in situ*—it is that of a young female.

GENERAL DESCRIPTION OF THE SKULL.

All the characteristics of the Tasmanian skull are in evidence, the age being certified to by the non-erupted wisdom teeth, and the following items of osteology:—

1. There is a trace of the frontal suture at the nason, and some evidence of it higher up as the frontal recedes to the bregma.

2. The pre-maxillo-maxillary suture is not ankylosed.

3. The occipito-sphenoidal suture is still spongy, complete ankylosis not having taken place.

In this latter connection it may be said that of three other female skulls of the same race, available to us for study, two show the suture open, with non-erupted wisdom teeth, and one shows the suture ankylosed to extinction with the wisdom teeth still in their follicles. A male skull, in which the left wisdom tooth had alone been erupted, manifested a completely ankylosed occipito-sphenoidal suture. The female skull cited, with the closed suture and non-erupted teeth, is a larger and heavier cranium than the one that

forms the subject of our paper, but is beyond all doubt that of a female, being in point of fact No. 26 of Prof. R. J. A. Berry's Atlas.

In our skull under review we find the inion slightly developed, but rather less so than obtains in the other female skulls used for comparison. It seems reasonable to suppose that the protrusion of the skull in this region was both an age and a sex character. Upon the right side there is a parieto-squamosal ossicle 25 mm. long; it is quite loose. No epipteric appears upon this side, although one is present upon the left.

The most striking instance of wormian ossicles found in this skull is that of a divided "Inca bone," the two moieties of which are similar in outline, their shape being cordate. There is an ossicle upon the right side of the skull, situated in the Lambdoidal, slightly below the last parietal contribution to that suture. This is not exactly duplicated upon the left side, but rather higher up, the parietal thrusts a bony dart into the occipital. Again, upon the right side an ossicle occupies the squamosal notch. Upon this side, therefore, there are three ossicles directly relating to the squamosal ("temporal") element. The most interesting of the eight old ossific centres, active in this skull, has yet to be called attention to, namely, one found in the right orbit. This is a minute island of bone in the osplanum, slightly anterior to its junction with the sphenoid, in short, the so-called "orbital process of the sphenoidal turbinate "bone," known at times to appear in the skulls of lowly races. Osteologically, we are here dealing with a last relic of the external plate of the old pre-frontal. The styloid processes were not ankylosed to their respective bases (the tympano-hyals), and may not have even been ossified, but in any case they are missing, and the squamosal piers manifest the condition of articulation by syndesmosis with the stylo-hyals. Such conditions point to immaturity.

THE TEETH.

The palate of this truly primitive human being is a perfect horse-shoe shaped cavity, and the lingual aspect of the tooth line slightly widens as it goes backward, and is thus in marked contrast to that which obtains in the higher ape—*Troglodytes gorilla*—in which the tooth line is absolutely straight in antero-posterior extension. This posterior extension of the palate is in direct relation to the added width

of the face, and, all things being even, should not strongly alter the points of contact of the several teeth as the evolution of the human race proceeded. The Dentist of to-day, however, finds that the blending of races by intermarriage and the inherited effects of disuse, have both changed the character of the palate and altered the dental points of contact—essentially for the worse! In these circumstances a primitive skull, such as that before us, is of great value as an indication of the racial base line upon which modern complex conditions have been reared. In the gorilla the points of contact of the five cheek teeth are practically *central* and *even*, but in the primitive human the widening out of the palate rolled these points slightly to the labial aspect, the pivot point being the posterior surface of the last pre-molar. It seems reasonable to suppose that degeneration of the human palatal conditions would tend to reverse this outward thrust, and that, as a natural result, the present-day contracted and distorted palate would follow. In a word, the complex man of to-day—the sum total of all antecedent individuals—reverts to a period of racial history in which he first began to make human history, as such, and departed from the anthropoid apes in his long upward climb. An examination of the second molars of this skull shows that the lingual cusps are higher and more worn than the labial ones, which is exactly what might be expected if the outward thrust of the tooth line was more strongly marked at the alveolar line than it was at the floor of the palate. Put in another way, the maxillary walls of the palate bent outwards at a more rapid rate than the maxillary moieties, that constituted the floor of the palate, increased in width. The reversion of one, or both, of these osteological changes, together with characters later acquired through alterations of diet, are the potent factors in abnormal human dentition to-day. In conclusion, it may be said that "Cobia," the lowest and most debased of Tasmanian Natives, has a palate that makes a nearer approach to that of the gorilla than any other Native's skull available to us for study.

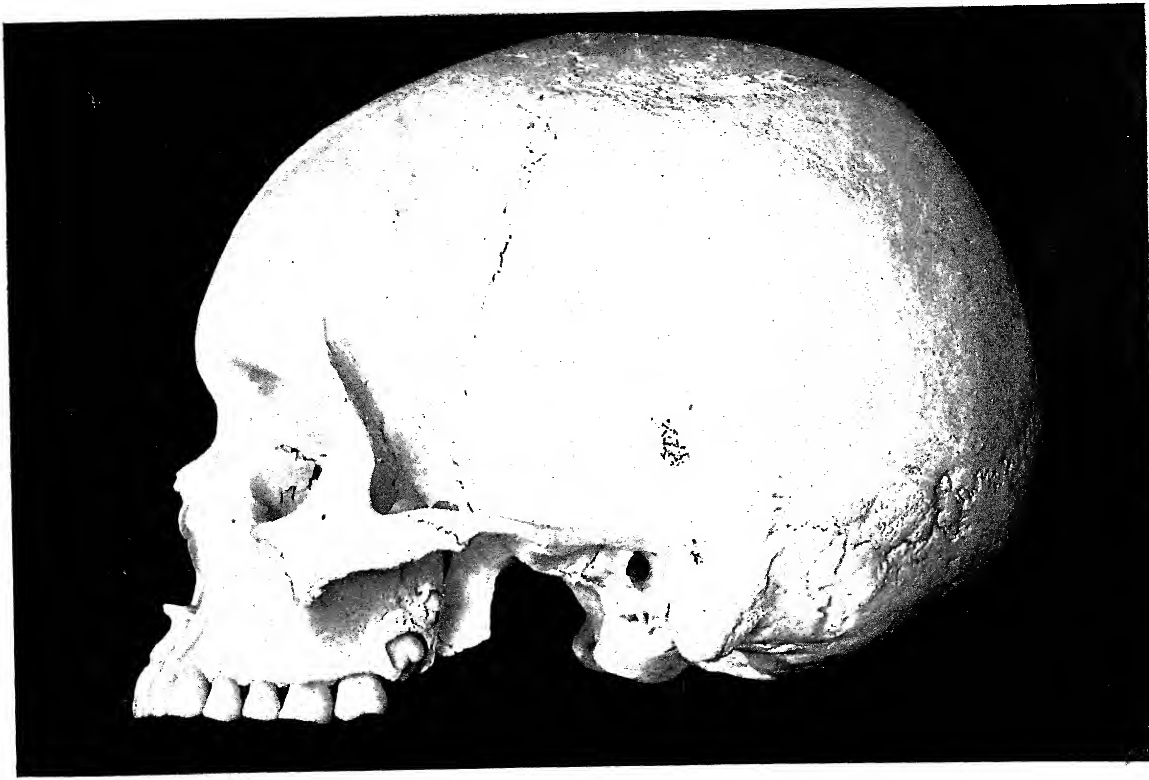
THE ORAL CAVITY.

The oral cavity is large, with a well-formed round arch; the vault is ample, but nearly flat. All the bony elements that enter into the formation of the cavity are regular in outline and well defined. The articular sutures are clearly marked. In the median suture, distad of the interproximal space of the central incisor, lies the anterior palatine for-

amen, a single, large aperture, and, therefore, in contradistinction to the conditions that obtain in skulls of the higher races, where it usually appears as a group of four foramina. Immediately behind this foramen is the suture of the incisive bone—which pre-maxillary suture extends across the junction of the maxo-maxillary for about 5 mm. upon either side. The maxillo-palatine suture is to be noted in the item of its left branch leaving the central line 4 mm. earlier than the right moiety. The posterior palatine canals are large, and occupy a position approximately centrad of the last-named suture. Several accessory palatine foramina exist behind them. The general surface of the maxillary is rough, and penetrated by a number of minor foramina; also, here and there, the outer table of the bone is raised into projecting points and ridges. The most marked instances of the latter are to be found near the maxillo-palatine suture, just in line with the posterior palatine canals. Externally, the maxillary bone conforms to the outline of the arch, its surface being alternately grooved and ridged in a vertical direction, thus indicating the rooting of the six anterior teeth and the two pre-molars. We note also that here, as within the arch, numerous foramina penetrate the alveolar rims. Several nutrient foramina are also to be found upon the facial portion of the maxillary, centrad of its junction with the malar. Reverting to the palatine areas again, we may note that the right internal pterogoid plate ends in a well-marked hamular process; mutilation has unfortunately robbed the skull in this respect upon the left side.

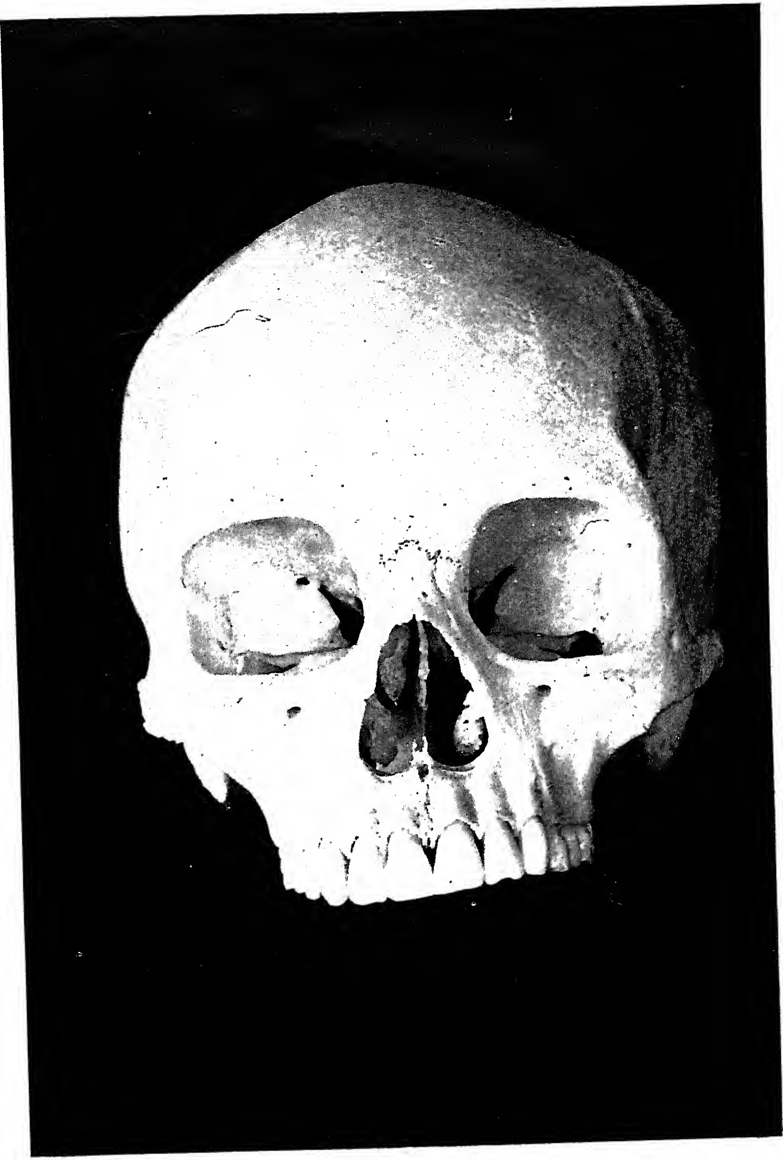
TEETH.

The skull is abnormal in having 17 teeth *in situ*, 14 being those duly erupted during life, and the remainder are in their respective dental follicles. The third pair of molars were upon the eve of eruption, the over-lying bone having been fully absorbed. The abnormal molar, which is situated upon the left side about half-way up the zygomatic surface of the maxillary, is apparently imperfectly calcified, its surface is soft and crenated. With the exception of the two central incisors, which are slightly rotated towards the median line, all the teeth present a beautiful curve, the individual teeth taking their places with unerring accuracy, and with perfection as to points of contact. The incisors, which taper in outline, have broad cutting edges—sides that taper to a small rounded neck; the mesial sides mark



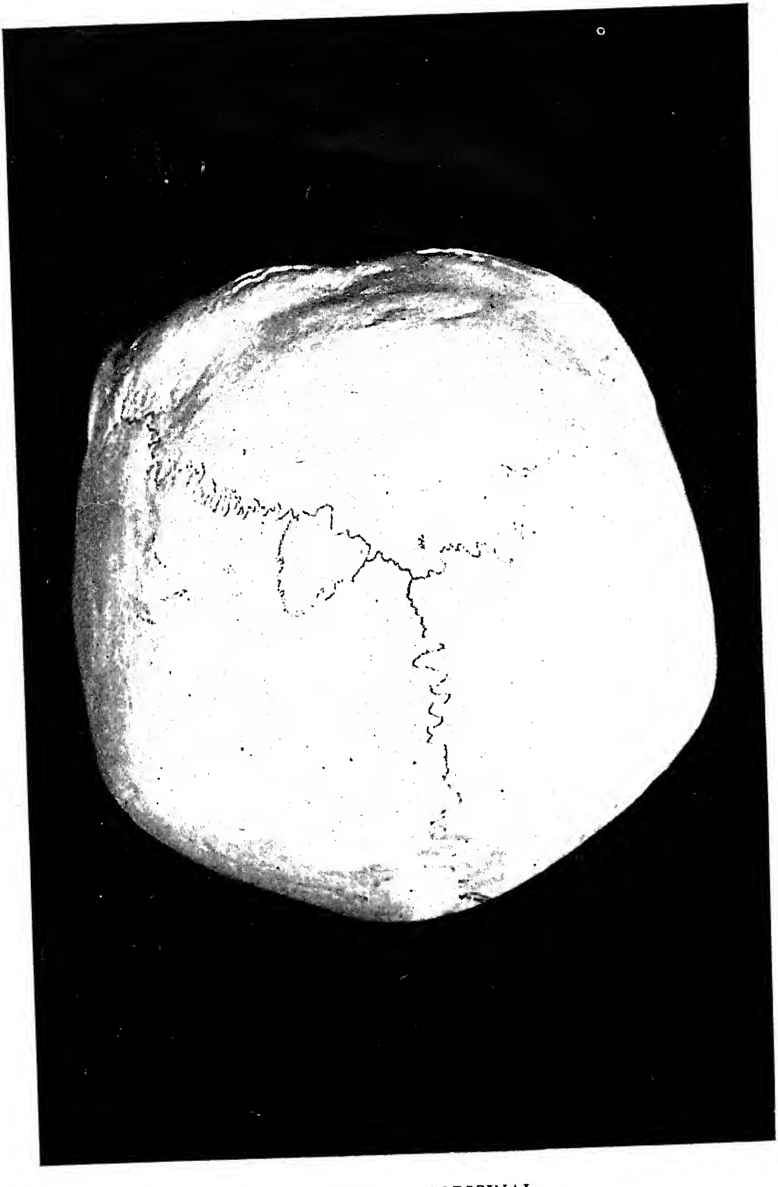
TASMANIAN ABORIGINAL.

The Skull in *Norma lateralis*.



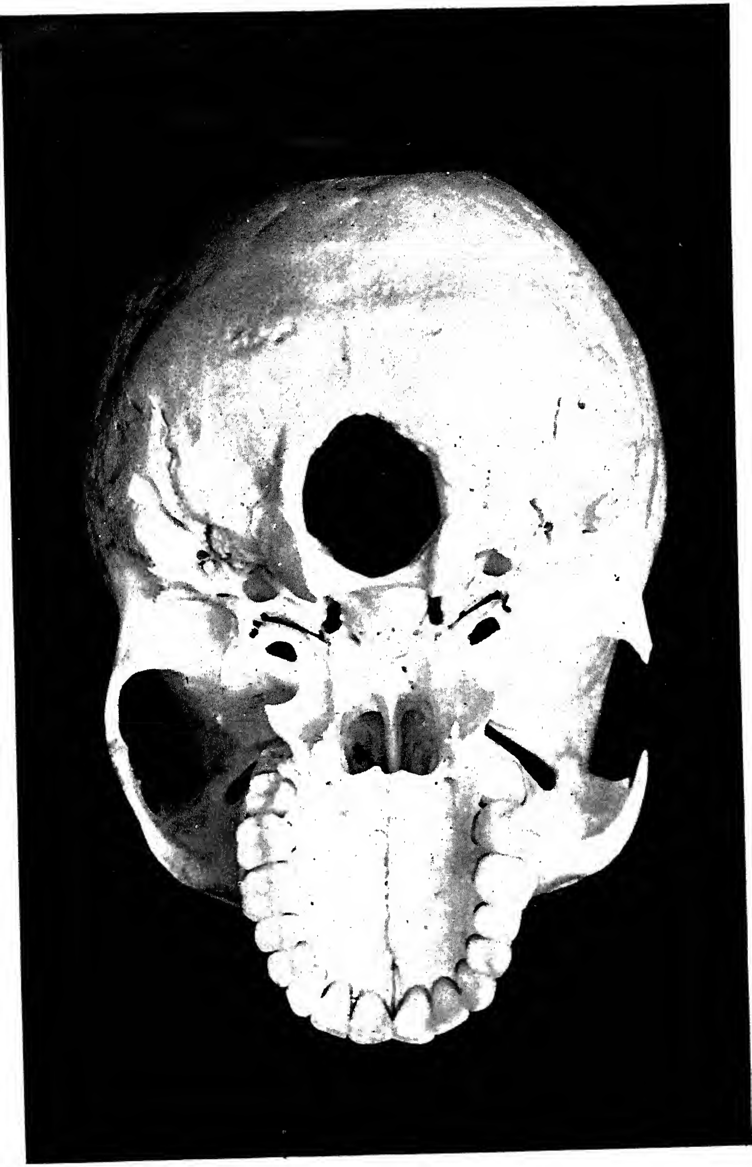
TASMANIAN ABORIGINAL.

The Skull in *Norma facialis*.



TASMANIAN ABORIGINAL.

The Skull in *Norma occipitalis.*



TASMANIAN ABORIGINAL.

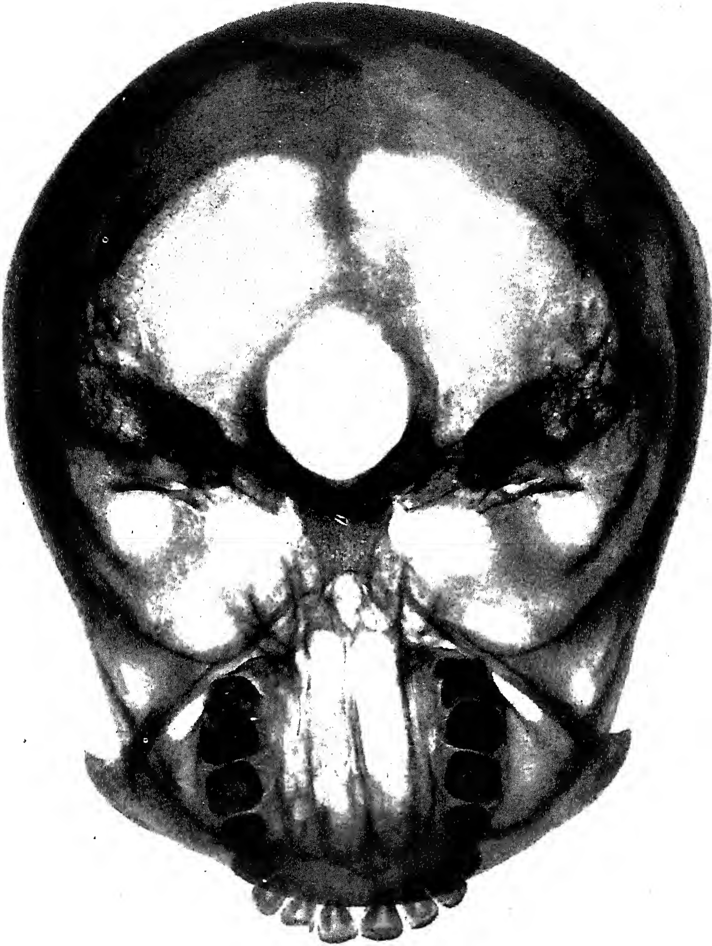
The Skull in *Norma basalis.*

TASMANIAN ABORIGINAL.

Skiograph of the Skull in *Norma lateralis*.

TASMANIAN ABORIGINAL.

Skiograph of the Skull in *Norma facialis*.



TASMANIAN ABORIGINAL.

Skiograph of the Skull in *Norma basalis*. (Complete view.)

TASMANIAN ABORIGINAL.

Skiograph of Palate and Teeth. (Viewed in *Norma basalis.*)

the sharpest angle with the plane of occlusion. Upon both incisors and pre-molars the developmental marks may still be traced, although the effects of action upon coarse food have started to become manifest. Upon the left hand side of the arch, with the mesial angle of the left central incisor as a starting point, the plane of occlusion bears away from the normal about 5 degrees in a graceful curve, and does not become normal again until we reach the second pre-molar—effects incidental to excessive chewing upon this side. The lateral incisor shows a deep indentation upon its cutting edge. The lingual surfaces of all the teeth are highly polished as the natural result of correct usage. The pre-molars and the first molars upon both sides show the effects of attrition, but the second molars (although well polished) only show wear upon the lingual cusps. With the exception of the abnormal fourth molar, all the teeth are physically perfect, and without structural defects such as commonly obtain among the white races of to-day. The radiographs show large pulp canals in all the teeth, and an absence of bone absorption; in a general way, these data indicate youth. The rooting of the teeth is as follows:—Incisors single rooted, pre-molars double rooted, first molars triple rooted, while the roots of the second molars are drawn to a point. This latter is to be regarded as a special provision of nature to allow of the mutual adjustment of the occlural surface to conform to the curve of occlusion, and thus assist the act of food mastication. The gingival surfaces are all healthy, and devoid of any pathological conditions such as follow upon the ravages of pyorrhœa. In conclusion, it may be stressed that the vigorous jaw action incidental to the grinding of coarse food called out such a rich supply of blood as to fully nourish the teeth, and much of their perfect condition may be directly traced to this important factor.

After the above notes had been written Dr. William K. Gregory's work upon the Origin and Evolution of Human Dentition became available to us, and we notice that upon page 421 he figures (after Keith) a Tasmanian palatal arch, and compares it with that of a Mousterian Youth and certain primitive apes.' As our photographs will show, the arch we are dealing with is much nearer to that of the Mousterian than it is to the Tasmanian outline he re-produces. In this connection we also desire to record the fact that four female and six male skulls available to us all *agree in having palatal arches of this type*, but that an eleventh skull (that of

"Cobia"), as we have already stated, is more gorilla-like, and in a general way conforms to the figure by Keith. We also call attention to the note upon page 478 of Dr. Gregory's work respecting "shovel shaped" incisors, and invite attention to the shape of the incisors shown in the skull we have under study; their extreme perfection should supply useful data for future workers in this field of research.

EXPLANATION OF PLATES.

Plates I.-VIII.

1. The skull viewed in *Norma lateralis.*
2. *Norma Facialis.*
3. *Norma occipitalis.*
4. *Norma basalis.*
5. Skiograph of *Norma lateralis.*
6. Skiograph of *Norma facialis.*
7. Skiograph of *Norma basalis.*—Total outline, with internal structures.
8. Skiograph of *Norma basalis.* Teeth and palate only.

All Photos by Dr. R. McClinton.

ON THE OCCURRENCE OF *WOLFFIA ARRHIZA, WIMM.*, IN TASMANIA.

By

L. Rodway, C.M.G., Government Botanist.

(With 5 Figures.)

(Read 15th April, 1925.)

Marsh plants have generally the widest distribution, and of the Duckweeds these are no exceptions. *Lemna minor, L.*, and *Lemna trisulca, L.*, both cosmopolitan species, are the only plants of this family that have hitherto been recorded from Tasmania. We now may report *Wolffia*.

Growing in a marsh near Lewisham, also on Maria Island.

The species of *Lemna* float horizontally on the surface of the water, or if quite submerged, which often occurs with our plants of *L. trisulca,* their position is still horizontal. Each plantlet sends a single rootlet from the centre of its under-surface; in one species, not Tasmanian, more than one of these slender rootlets develop, while the rootlet is often absent from fronds of *L. trisulca.* Another feature of this genus to which we may refer is the fact that the plants are bisexual; the flowers are very rare, and arise from the edge of the frond, and mostly consist of two stamens and one carpel. Propagation takes place by lateral budding.

The genus *Wolffia* is of quite a different structure. Instead of floating horizontally, it does so perpendicularly, exposing an edge to the air and sinking the greater portion of the frond as an oblique plate. Flowering is unisexual, and takes place in the centre of the exposed portion. It bears no root.

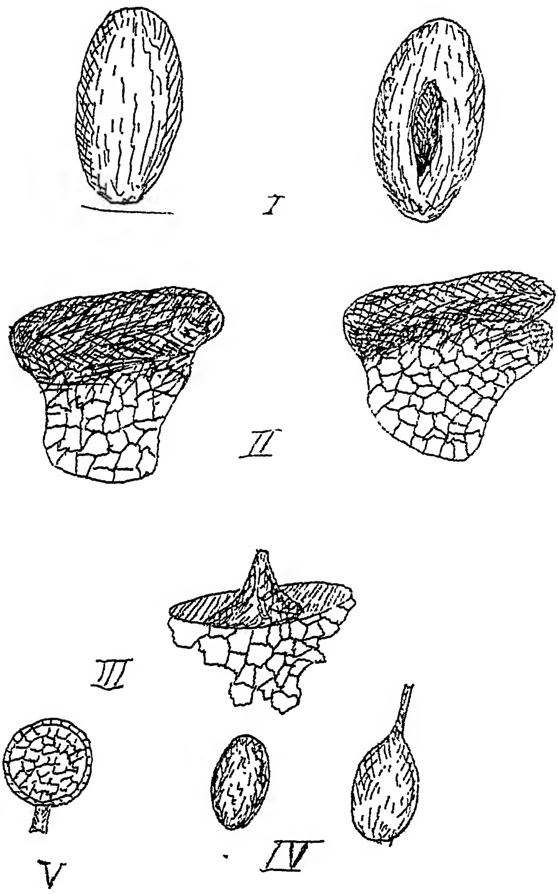
The following is a description of *Wolffia arrhiza* as found in Tasmania:—

In surface view the exposed portion of the frond is oblong, convex, 1 mm. long by 0.5 mm. diameter, green, cells small. In perpendicular aspect the frond extends below into

an oblique colourless process, the epidermal cells large and the inner ones smaller, but all colourless; the green portion forming a disc about 0.3 mm. thick. Propagation takes place by budding on the concave edge.

When a frond proceeds to flower a fossa forms in the centre of the green surface, and at the base of this fossa, whether staminate or pistillate, the flower forms. The male flower consists of a single stamen, 130μ. diameter, white, globular, unilocular, the wall of which is formed of a single layer of muriform cells. Pollen grains spherical, minutely echinulate, 16μ. diameter. The stamen is borne on a short filament; it protrudes from the fossa at maturity. The wall soon disintegrates, and the dry pollen drifts away on the surface of the water in quest of a projecting stigma.

The female flower consists of a single flask-shaped carpel, elongated above into a short style, ending in an irregular stigma, altogether about 250μ. long. The carpel contains a single erect orthotropous ovule. After fertilisation the ovule becomes slightly enlarged and indurated, the ovarian walls shrivel up, but the seed usually remains in the fossa. The whole plant sinks to the bottom and rests in the mud.



EXPLANATION OF FIGURE.

Fig. I. Upper view of sterile and fertile fronds.

Fig. II. Lateral view.

Fig. III. Seed condition.

Fig. IV. Carpel and ovule.

Fig. V. Stamen in section.

Variously magnified.

THE R. M. JOHNSTON MEMORIAL LECTURE, 1925.
THE MAMMALIAN TOILET AND SOME CONSIDERATIONS ARISING FROM IT.

By

FREDERIC WOOD JONES, D.Sc., F.R.S.,

Elder Professor of Anatomy in the University of Adelaide.

With 23 Text Figures.

(Read 7th May, 1925.)

Few ways of honouring a departed pioneer in science could be conceived as more appropriate than the establishment of a memorial lecture. Among the memorial lectures that have been founded the world over to commemorate the life and work of outstanding men in the realm of Science, the R. M. Johnston Memorial Lecture may be considered as a younger member. For this very reason the delivery of the lecture becomes a matter for careful deliberation. Should the lecturer attempt to interpret some phase of the work of the pioneer in whose honour the lecture is delivered? Should he take some episode from the career of the leader and elaborate that into a theme into which his own work may be woven? Or should he merely give his own and, as far as his ability lies, the best of his own, as a tribute to the memory of the man whose life work the lecture honours?

I am tempted to adopt this last course, and this for two reasons; the one that certain memorial lectureships have an accepted standard, to which successive lecturers, over the interval of centuries, have attempted to attain, of expounding the doctrines of some great teacher.

It has often seemed to me that in these lectures there was a possibility that the lecturer might have had a message to deliver, but that in paying tribute to the master and attempting some familiarity with his writings and his work the message has become so subordinated as to be well nigh undecipherable.

The second reason for departing from the tradition that clings to certain memorial lectureships and, thereby, in establishing a precedent in this one, is that my predecessor

in this office, Professor Sir Edgeworth David, delivered what might be termed *the* R. M. Johnston Memorial Lecture.

There is no man who might be better trusted to place an appropriate verbal wreath upon the tomb of a scientific pioneer; no man who could better strew the pathway of memory with the petals of well merited praise than Sir Edgeworth David. It might be said that, as a memorial lecture, he has left this office a barren one by virtue of his own tribute.

I feel, therefore, that I am absolved from attempting a task such as Sir Edgeworth David accomplished. But I feel also that Sir Edgeworth's tribute is only one aspect of a memorial lecture; the other is to offer up, in memory of a great man, that which in one's present occupation seems most fitted to constitute a subject for philosophical reflection and for possible suggestion as to future lines of research. I shall, therefore, elect, as the R. M. Johnston Memorial Lecturer for 1925, to pay my homage rather in the form of a lecture which introduces certain matters for homely consideration than in attempting to elucidate any phase of work, or in dwelling upon any special researches, of the man whom we are met to honour.

Who first invented proverbs I do not know. There is a suggestion of the East about many of them, but probably they are common to all humanity. Most proverbs are retained in common usage since they may be employed as maxims wherewith age and experience may advise or admonish youth and inexperience. But some are double-edged. The child who is reproved for adopting the natural method of eating with his fingers has always in the background, even if it comes no further into usage as a very present help in time of trouble, the saying that "Fingers "were made before forks." The child is in the right. It is true, fingers *were* made before forks, and herein lies the charm that captivated Samuel Butler.

Butler's was the mind that placed forks and fingers in their proper perspective. What is a fork but a finger made, as we say, artificially? What is a fork but an extended organ —an external organ? Did we not make both? As Butler himself said (1): "The organs external to the body, and "those internal to it are, the second as much as the first, "things which we have made for our own convenience, and

(1) *Evolution, Old and New*, Reprint, Fifield, 1911, p. 39.

"with a prevision that we shall have need of them; the main "difference between the manufacture of these two classes of "organs being that we have made the one kind so often that "we can no longer follow the processes whereby we make "them, while the others are new things which we must make "introspectively or not at all, and which are not yet so incor- "porate with our vitality as that we should think they grow "instead of being manufactured. The manufacture of the tool "and the manufacture of the living organ prove, therefore, to "be but two species of the same genus, which, though widely "differentiated, have descended, as it were, from one common "filament of desire and inventive faculty."

Tools and limbs—there is not much between them. The limbs are part of us, and made in our own making; the tools are only temporarily part of us, and made independently of our structural unfolding. Forks and fingers; if we regard them as Butler did, there is not a great difference between them. Fingers grow on us, forks are part of us only during meal times; but we shall see that there is a very pretty sequence in the development of these things.

Fingers were made before forks, that is true. But think of how many things were made before fingers were invented, and, in order to limit the discussion, think of how many other things were made in order to assist and extend the office of the fingers in some very humble processes—functions which we are usually prepared to forget or to pass over.

Most people have a proper respect for the scientific worker whose daily occupation leads him to contemplate the ordering of the movements of the heavenly bodies, and even the man who spends laborious days in unravelling the story of atoms is recognised as one living in an elevated sphere of mentality. But what can be said for the man who has a mind of such a homely type that he is willing to be perplexed by the problem of how animals keep their ears clean? The process of keeping the ears clean is one that is generally considered to be hardly worth studying, and certainly one of which the importance does not excuse the nastiness. The business of keeping the ears clean is, however, only a detail in a great scheme of processes, some of the other details of which are far less suitable for polite discussion.

The whole great assemblage of processes we may group together under the title of Toilet Operations.* These little operations are homely enough things, and yet if we are pre-

pared to forget their lowliness, and what might even be termed their unpleasantness, there are several lessons to be learned from them. Just as fingers were made before forks, so were fingers made before tooth brushes and tooth picks. But what preceded fingers in those animals in which the digits are so altered as to be useless for these functions? We shall see that, in almost all toilet operations, nature has invented some peculiar device for the performance of the function; that this device is rudimentary or absent when the animal possesses fingers, which can perform the operation better; and that, as a final stage, man has invented other artificial members to replace the use of the fingers. The sequence is in three stages. First there is the local mechanism, then there is the digit, and last the external instrument. Ears must be kept clean—every schoolboy knows it. In many animals there are structural specialisations developed for this purpose. There are processes of the external ear developed for shutting up the passage. There are, in many marsupials, for instance, mechanisms for folding the whole ear and protecting the inner parts; and then there are all sorts of specialised glands and specially directed hairs for keeping the passsage free from foreign bodies. In us some of these things persist. We have a complete system of wax glands, and secretor-motor nerves supplying them; we have rather variably developed specialised bristle hairs (vibrissæ) in the external auditory meatus. The wax that is secreted from the wax glands is a peculiar substance, its function seems obviously to be that of snaring particles of foreign matter gaining access to the external auditory meatus. It is a substance that does not decompose; but it slowly shrinks and dries after it is excreted. It seems as though in our ears wax were secreted at the bottom of the external auditory meatus, that it was destined to dry up, but that there was no normal mechanism for expelling it from the external auditory meatus. Indeed, we know that aural surgeons who are specially gifted in curing deafness are commonly especially skilled in the simple business of removing wax from the ear. But many years ago I was told by an aural surgeon that there was a mechanism provided for ridding the human ear of the wax that has been secreted and has accomplished its purpose. The wax, as it is secreted, enmeshes the vibrissæ, the axis of which is oblique. As it contracts it pulls these bristles down; but the turning point comes, the inspissated wax parts company with the surface of the

passage, the hairs straighten themselves suddenly, and the mass is loosened and freed. How true this dictum is I do not know, but that wax may be suddenly loosened from the ear, with a quite recognisable "click," is probably within the experience of all. I imagine that the explanation is a reasonable one, and I think that an inquiry along these lines might solve the problem of why some people are for ever becoming deaf, owing to the accumulation of wax, and others never suffer from this condition.

Whatever may be the mechanism of freeing the wax from the depths of the ear, there is no doubt that its ultimate removal is, in man, effected by the nail of the little finger. So obvious is the office of the little finger in this connection that for centuries the fifth digit of the manus was known to the learned by the name *Auricularis*. To-day we term it *Minimus*, but to my mind, though this name may be considered more polite, it lacks the distinction of assigning a definite function, however humble, to this digit.

In this matter of digital nomenclature we may take Diemerbroeck as our guide. Of the digits he says:—"The "first, which is the thickest, and equals all the rest for "strength, is call'd *Pollex* or the Thumb. The second is the "Forefinger from the use, call'd the *Index*, or *Demonstrator*, "the Pointer, because it is us'd in the demonstration of things. "The Third or *Middle*-finger is call'd *Impudicus, Famosus*, "and *Obscoenus*, the Obscene and Infamous, because it is "usually held forth at men pointed at for Infamy, and in "derision. The Fourth, the *Ring-finger*, or *Annularis* and "*Medicus*, the Physitian's-finger; because that Persons for-"merly admitted Doctors of Physic were wont to wear a "Gold Ring upon that Finger. The Fifth, call'd the Little-"finger, in Latin *Auricularis*, or the Ear-finger, for that "men generally pick their Ears with it." (2)

It may perhaps be doubted if this explanation of the name "obscoenus" for the third digit is correct. We all know of the degradation that results from being pointed at with the Finger of Scorn; but I have a fancy that this is not the origin of that very peculiar name for the middle, or longest, digit of the manus. As for Auricularis, he is clear and direct. There is no gainsaying Diemerbroeck's explanation of the name.

(2) Isbrand de Diemerbroeck, *The Anatomy of Human Bodies*. Translated by William Salmon, London, 1694. Book III., Chapter II., p. 494.

After all, those of our race should be the last to be squeamish concerning the toilet functions of the fifth digit. With us it is not a case of fingers were made before forks, for we have not yet invented the successful fork unless the rolled up edge of the towel so much and so rightly dreaded by the child can be accounted as such. The fork, or its equivalent, has, however, been invented by others. Few, if any, of the Asiatic races are without a definite instrument for cleaning the external auditory meatus. In the splendid coils of her black hair the Malay woman wears a little silver pin some six inches long; one end of this ornament is pointed, the other, which is crooked, is fashioned like a tiny spoon. This is the Korek Kuping, and, though it is an ornament worn becomingly in the hair, it is also a functional instrument, the use of which is the toilet of the external ear. (See Figure 1.) Fingers were made before Korek Kupings, and

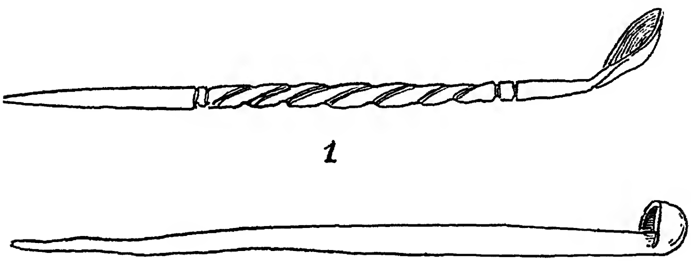


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Figure 1.—Two examples of the Korek Kuping—the toilet implement of the ear. (1) A Malayan and (2) a Chinese specimen.

we—though it may be on the sly—still employ the fifth digit of the manus for the office the Korek Kuping was designed to discharge. Although we have ceased to name it Auricularis, we still, behind closed doors, demonstrate the appropriateness of that name. It may even be suggested that the adoption of an instrumental Auricularis, such as is employed by Asiatic races, would be a movement in the direction of toilet refinement. It is true that such an instrument has been invented, and has been made available in chemists' shops. This invention, however, which was known as an "aurilave," was branded by the contemporary aural surgeon (C. H. Burnett, *The Ear*, 1884) as "that most pernicious "and reprehensible instrument," and, so far as I know, aurilaves enjoy no present-day popularity.

If we open the mouth of a dog and look at the margin of his lips we see that the condition differs very widely from that which we see when we look inside our own lips. The margins of the lips of a dog, or indeed of the lips of most mammals, are beset with curious little tags and frills. (See Figure 2.) These little tags are processes of the substance

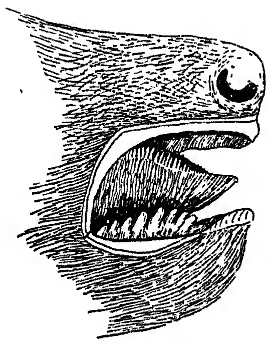

Figure 2.—The mouth of a Wolf Cub with the cheek removed, to show the papillæ growing from the lip and from the side of the tongue.

of the lips, bluntly pointed at the ends, and clothed with a surface epithelium, which is almost horny in its nature. If this frilled fringe of the lip is left in apposition with the teeth it will be noticed that the little processes lie against the teeth and that, when the lip is moved, the tags work up and down along the interspaces between the teeth and on the surfaces of the teeth themselves. If we look further into the mouth we shall notice that, on the inner side of the tooth row, there are other tags developed from the side of the tongue, or from a fold below the tongue. The outer row of tags, or labial processes, are variable in form in different mammals, but are constant in site, inasmuch as they arise from the margin of the lips. The inner row of tags may arise either from the sides of the tongue itself or from certain folds, the *plica sub-lingualis* or the *plica fimbriata*, below it. (See Figure 3.) All of us have admired the clean white teeth which most animals possess; and those who have regarded rats as being unclean, because their teeth are yellow, forget that the yellow colour is natural to the enamel of their incisors. The beautifully clean white teeth of the carnivora know no artificial tooth brush; they are innocent of tooth powder, tooth paste, or tooth pick. They are cleaned in the

common mammalian fashion by the play of the little rubber fingers of the lips and tongue.

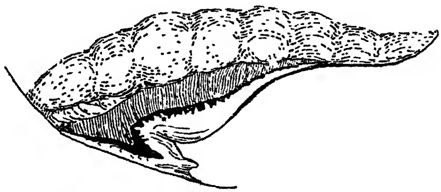

Figure 3.—The tongue of the Flying Opossum (*Petaurus breviceps*), to show the fringe of papillæ (plica fimbriata and plica sublingualis) along its side.

In the Primates these little tags are lacking, but it is not to be forgotten that the human child at birth shows a condition in which the lips are beset with little papillæ which seem obviously to be remnants of those which are present as a common mammalian heritage. (See Figure 4.) In the

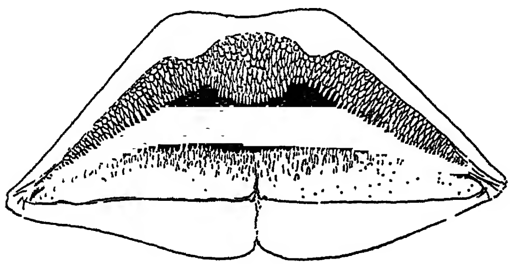

Figure 4.—The lips of a new-born baby, to show the little papillæ with which they are clothed (after Ramm).

Primates the intimate tooth cleansers seem to have been subordinated to the activities of the digits.

We have our tooth brushes and our innumerable dentifrices, but we must remember that our tooth brushes, by working along the line of our teeth and not up and down, as do the labial and lingual processes, are not so effective in cleansing inter-dental spaces as are Nature's methods. Nor must we forget that European tooth brushes are not the only kind invented by man, for many races use a brush which is applied up and down as are the lost intimate tooth cleansers. Such tooth brushes, which are very like the frayed-out ends of wooden meat skewers, are widely used, but though put on the European market have, I believe, never proved acceptable to European taste.

Even the up and down tooth brush does not exhaust the aids to dental cleanliness employed by some races, and for a complete armamentarium for the dental toilet probably the Chinese is as well equipped as any man. Perhaps it may here be said without shame that, for what may be termed the general toilet of the mouth, the European lags far behind the Asiatic. We Europeans have our tooth picks, which enjoy a curiously anomalous acceptance midway between covert usage and open display upon restaurant tables. These articles may be purchased expensively, wrought of gold and silver, or cheaply when made of wood or quill; but their recognition is only partial. They are not employed overtly as the tooth brush, the neglect of which is shame, they are not unknown as is the Korek Kuping; they are in a stage of recognition as implements but of disfavour as to public employment. We do not know if their usage is of the right hand or the left.

Fingers were made before tooth brushes and tooth picks; but before fingers there came a whole series of beautiful adaptations to the local mechanism of cleansing the teeth.

As with the ears and with the teeth, so with every other external part which may need toilet attentions.

No more delicate external organ than the eye can well be imagined; and although we must not fall into the popular error of supposing that eyelids are developed purely for the purpose of protecting or cleansing the eye, we must not overlook their office in this matter.

There is a very attractive Gecko, which is widely distributed in Australia, but does not extend its range to Tasmania, named *Gymnodactylus miliusi*, which in Australia has almost become legendary as the "Wagga," which stands on its hind legs, barks like a dog, and bites severely and venomously. It is a charming and harmless creature, which is certainly vocal and certainly stands erect on the tips of the toes of all four feet; but beyond that does nothing outrageous. Like all Geckos, it lacks moveable eyelids; but lacking one instrument, it uses another, and its tongue replaces the absent eyelids in the office of removing particles from the surface of the eye. *Gymnodactylus miliusi* has an attractive habit of solemnly sweeping its tongue over the surface of its eyes, and probably other Geckos can do the same. But though Geckos and other animals may employ expedients of this sort, the real mechanism for conducting

the toilet of the eye is the third eyelid, or nictitating membrane, acting in conjunction with the upper and lower lids. Though the upper and lower lids have other functions to perform—the third eyelid is a toilet implement pure and simple—its function is to sweep across the eye and remove particles and draw them across to the inner corner of the eye. It works like the Gecko's tongue. In all the monkeys this third eyelid is a mere rudiment, just as it is in man, but in some mammals it is of considerable size. As Robert Knox observed, "The third eyelid, perceptible enough in man, "though clearly a vestige; more developed in the ox, horse, "dog; still more in the elephant; most of all in the bird— "ever the same elements nearly are found in all; it is merely "a question of size and function, but not of kind or "organisation." (3)

We are so used to being able to remove foreign bodies from the inner corners of our eyes by the use of our finger tips that it is difficult to picture the condition in those animals in which no instrument save the innate toilet mechanism of the eye exists.

It would seem that the mobile, inquisitive, and resourceful finger had usurped the functions of many very beautiful mechanisms, and let it be remembered that in the three simple examples of the ear, the teeth, and the eye, which have been instanced by way of introduction, we have only invaded the marches of this great realm of the special digital toilet.

Would you hand the sweetmeats to a son of Islam you must elect the right hand for that office; for there is a specialisation in the usage of the hands for offices polite or impolite. I have, in the examples I have cited, chosen somewhat from the right handed offices of our digits. Not only have we limited ourselves to the more or less honourable use of the digits, we have also limited ourselves to certain special portions of the body, which may be defined as the orifices of certain sense organs—though from choice we have left the nose out of account. In all this we have not considered the great question of the toilet of the general surface of the body, the toilet of the coat, the business of keeping the whole of the skin and hair orderly and clean. In this business many mechanisms play, or have played, their parts, and we should look to see wide differences in the toilet appliances, for there are wide differences in type of

(3) Robert Knox, *Great Artists and Great Anatomists*, 1852, p. 196.

the toilet to be performed. A hairy coat is the birth-right and the hall-mark of the mammal, but the nature of the hairy coat varies widely, since a mammal may be clothed with spines or bristles, with harsh, coarse hair, with fine silky, velvety, or woolly fur, or it may be relatively or absolutely naked.

For all sorts and conditions of spines, hairs, and furs there must be a special and definite toilet and a definite toilet mechanism. There is also another consideration; there may be parasites of very varying types that find lodgment in the coats or upon the skin of the animal. The presence and the nature of parasites are important factors, and they have probably played a conspicuous part in the begetting and moulding of toilet implements.

We brush our hair when we rise in the morning, we may do it again in between times and before we retire at night. Animals perform the toilet of the coat at very varied intervals; some do it only when the call is imperative, some perform it almost without ceasing during their waking hours. As a homely example, the cat is for ever at its toilet when not otherwise employed; the dog devotes its energies to a good scratch only when the insistent attentions of a flea, or something of the sort, have evoked an imperative desire to scratch. In this very homely illustration there lies a deep physiological truth. The dog possesses the well-known "scratch reflex"; tickle his front ribs, and his hind legs will start scratching movements in response. The cat has no such generalised reflex, save for a slight local manifestation around the ears. You may tickle a cat's ribs as long as you care to do it, but you will never produce a sympathetic twitch in its hind leg, such as may be evoked on an instant in a dog. The coat toilet of the cat is a deliberate operation, the occupation of a well-employed leisure. The coat toilet of the dog is a reflex and unconsidered affair, imperative, utilitarian, and unæsthetic in its manifestation.

There are many ways in which the toilet of the surface of the body may be conducted, and in order to introduce some system into their study it is best to take the different methods and examine them separately.

(1) BY RUBBING AGAINST EXTERNAL OBJECTS.

This may be termed the method of the itching post, and it is a favourite method with certain animals that lack toilet implements of their own.

It is because of the general lack of toilet implements among the *Ungulata* that this rubbing against posts and trees has become so characteristic of them. The hoof prohibits scratching. As the animal cannot scratch itself, it must find something which will do the scratching for it. It invents a toilet implement; though it has not made a fork it has found an itching post.

(2) BY BRUSHING OR FLICKING WITH THE TAIL.

These methods play no great part in the toilet of the coat as we are here considering it, nevertheless they are important enough from the point of view of the animal. It is again in the *Ungulata*, cursed with the hoof instead of the hand, that the tail functions so predominantly as a toilet organ. In the study of structure and function, it would perhaps be difficult to find an organ of such outstanding interest as the tail. This dead end of the vertebrate body, left over after the body and its organs are fashioned, is ever available for some office. The various uses that have been made of it afford material for a bulky thesis.

Could John Hunter, the Very Revd. William Paley, and Samuel Butler have entered into partnership and produced a joint work upon the uses of the tail we would have had a regard for the tail almost as great as we have at present for monkey glands or pituitary bodies. The mammalian uses of the tail are legion; in comparatively few animals does it function as an instrument of the toilet, and then its office is called upon only because some other, and more customary, instruments are at fault. The horse, for instance, relies on its tail to perform the office that would be fulfilled by the teeth or the claws of a dog.

(3) BY SCRATCHING WITH HORNS OR ANTLERS.

This method of conducting the toilet of the coat is again a limited one, and one that does not lead us far. As with the itching post and the tail, it is mainly a toilet substitute of the *Ungulata*. Scratching with horns and antlers is necessarily limited in its manifestations in the mammalia; it is limited also, even in the horn-bearing animals, to the parts of the body to which it can be applied. A stag, an antelope, or a cow can scratch only a limited part of its body with its antler or its horn. Although these things play a definite rôle in the toilet of the coat, their rôle is limited in area and limited in its display among the mammals.

(4) BY TWITCHING WITH MUSCLES.

Everyone has seen this simple toilet operation performed by a horse; the little flicker that runs beneath and shakes the skin is familiar to everyone. The special subcutaneous muscle sheet which produces this twitching is very variably developed, and is put to many uses in different animals; as a toilet muscle its great function is to dislodge from the skin flies, parasites, and foreign particles which lodge upon portions of the body difficult to reach with any other toilet instrument. For our present purpose the panniculus carnosus sheet, which is a toilet muscle in so far as it is a twitching muscle, is of only minor importance, although twitching as a fine art is seen at its best among the marsupials.

(5) BY LICKING WITH THE TONGUE.

The tongue is in very different case from the other toilet instruments we have reviewed. The tongue—the member most unjustly named unruly—is one of the most perfectly adjusted neuro-muscular mechanisms in the body. A marvel for precise action, a revelation for obedience to cortical control, the tongue seems ever ready to take on new offices. Among these offices a conspicuous one is that of conducting the toilet of the coat by the process of licking. Although it is a simple thing to watch animals and to appreciate the enormous importance of the tongue as a toilet instrument, it is by no means easy to determine what modifications of the tongue itself are due to its toilet offices. In writing of the Lion's tongue, Flower and Lydekker (4) say:—

"The tongue, like that of every other species of the "genus, is long and flat, and remarkable for the development "of the papillæ of the dorsal surface, which (except near the "edge) are modified so as to resemble long, compressed, re-"curved, horny spines or claws; those near the middle line "attaining the length of one-fifth of an inch. They give the "part of the tongue on which they occur the appearance and "feel of a coarse rasp, and serve the purpose of such an "instrument in cleaning the flesh from the bones of the "animals on which the Lions feed." This rasping flesh from bone is a business of which we have all been told, and I would not dispute that it indeed may be an important matter. That the curious roughness of the tongue of the cats is in reality begot for flesh-rasping is to my mind a

(4) *An Introduction to the Study of Mammals, living and extinct,* 1891, p. 507.

very doubtful supposition. I think it may be contended that among the functions for which this peculiar roughness would be required, the business of coat toilet far outweighs that of flesh-rasping when we come to observe the habits of, even, a domestic cat. Although the flesh-rasping function has become the accepted and traditional explanation of the peculiar rasp-like nature of the tongues of the *Felidæ*, I feel certain that the brush-and-comb tongue is essentially a toilet implement, and that the flesh-rasping habit is rather a minor one, magnified in order to explain a very peculiar structure. In such a study as this we must not forget that apparent triviality may be compensated for by frequency; a condition that is often not duly considered. The toilet of the Feline's coat is a never-ending business, for every once that a cat's tongue is called upon to rasp flesh from bone it is employed a hundred times as brush and comb and sponge in one.

The toilet of the cats is a remarkable affair, and one well worth watching. It will be noted that the animal licks all parts of its body that are within direct reach of its tongue, and the tongue can reach almost all its body save the sides of the face, the top of the head, and the back of the neck. In order to conduct the toilet of these parts the cats have perfected a toilet process, which, so far as I know, is confined to them; they lick the side of the paw and cleanse the head and face with that. This use of the furry manus as a sponge is, I believe, unique with the *Felidæ*, but I by no means feel prepared to uphold the thesis that, when the operation is carried to the backs of the ears, rain is likely to follow.

It is not only cats and the other members of the *Felidæ* that lick their fur for the purposes of the toilet. Many marsupials lick wide areas of the body; but here only a certain element of this extensive operation may rightly be claimed as a toilet process. I do not know that it has been sufficiently appreciated that this extensive licking of the marsupials is merely a substitute for perspiration. In very hot weather, dogs, which cannot sweat, loll out their tongues and evaporate moisture from the wet surface. This is a substitute for sweating. Many marsupials, such as opossums and kangaroos, when distressed by the heat, lick the whole of the forelimbs, and with increasing need for heat radiation moisten large areas of the body by means of licking with

the tongue. This operation must not be mistaken for a procedure for conducting the toilet. It is merely a means of providing an evaporating surface, in the absence of sweat glands. There is, however, in almost all marsupials a residual licking, which is purely a toilet operation, and this is the business common to all mammals that, to use the recognised expression, lick their chaps. Apart from the elaborate feline tongue-toilet, and apart from the common mammalian process of the licking of the chaps, many animals have a limited toilet of the coat which is conducted by the tongue. Most *Ungulata* lick these portions of the body (and they are limited) which can be reached with the tongue. Everybody has seen a cow turn its head and lick the very small area available to the exploration of its tongue. There is an interesting sequel to this business of licking the coat. Should the condition of the coat be below normal, the tongue toilet becomes increasingly necessary. The accumulated hairs licked from the coat must be got rid of, just as we must remove the hairs from hair brushes and hair combs. Under normal conditions it is to be presumed these hairs are either ejected from the mouth or swallowed. In any case the amount of hair to be disposed of as the result of any individual toilet operation would be inconsiderable. But if the animal happened to be shedding its coat, it is possible that after each overhauling of the coat by the tongue a relatively large mass of hair is taken into the mouth, and the bulk of this will be swallowed. In this way result those homely products, elevated by age-long legend into the realms of the mysterious and occult; the simple or calcified hair balls of the pathologist, the fabulous, the priceless, the incomparably potent antidotes of the alchemist. Of these things Gaspar Schottus (5) wrote:—"Quam notus est lapis, quem Bezoar alii, alii "Bezaar, et alii Belzaar, hoc est (ut ajunt) veneni dominum, "seu veneno dominantem appellant"; and then the author tells much of mysteries and goats from the Indies which do not appropriately come under the heading of the Mammalian Toilet. Taking it all round, from the rasps of the Lion's tongue to the Bezoar stone of the *Capra bezoardica*, the business of the coat toilet conducted by the tongue is a large one, and it must be remembered that here we have only mentioned self-licking; there is a wide extension of the subject when we also take into consideration mother-conducted and mutual licking.

(5) *Physica curiosa*, 1667, Liber VIII., p. 858.

(6) BY COMBING WITH THE TEETH.

In the business of combing the fur with the teeth lies, from an historical point of view, perhaps the greatest interest attached to any of the toilet implements. It was Cuvier who, in 1829, called attention to the function of the curious procumbent lower incisors and canines in the Lemurs. When describing *Lemur catta*, Cuvier mentioned a curious habit, and he recorded that:—"Ces animaux sont portés, par "leur instinct, à se gratter mutuellement avec ces dents, qui "semblent ne leur avoir été donnés que pour nettoyer leur "pelage; car ils ne s'en servent jamais ni pour mordre, ni "pour couper; ce sont de véritables peignes." (6) This simple observation, made nearly a century ago, has often been overlooked by succeeding generations of zoologists; but of its accuracy there can be no doubt whatever. The four lower incisors of the Lemurs have become altered in form and in position, and, moreover, the lower canines have also participated in the change, and have become so thoroughly modified in the same direction as the incisors (see Figure 5) that they have frequently been mistaken

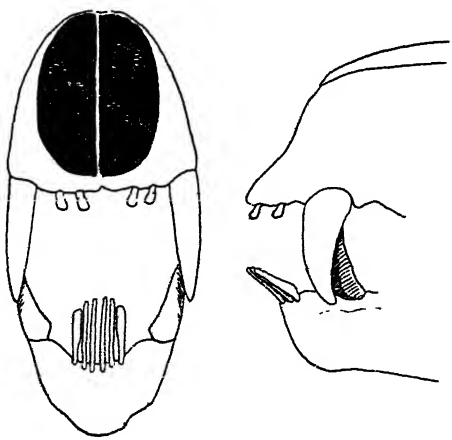

Figure 5.—The front teeth of a Lemur (*Lemur catta*), to show the adaptation of the six lower anterior teeth to the purpose of a hair comb.

as being incisors themselves. These six lower teeth have become elongated and compressed from side to side; in form they can only be likened to the teeth of a comb. They have also become altered in position, so that, instead of being

(6) Geoffroy Saint-Hilaire et F. Culvier, *Histoire naturelle des Mammifcres,* 1829, p. 218.

directed towards their fellows in the upper jaw, they project almost straight forward. In consequence of this alteration in their axis the upper incisors are left without anything to bite against, and they have become reduced and probably almost functionless structures. There is no doubting the anatomical fitness of these lower front teeth for the office of a hair comb; there is no doubting the frequency with which they are put to that use by the Lemur. One has only to watch a waking Lemur for a short while in order to witness the use of the dental hair comb. Carefully, with downward strokes, the hair comb is passed through the hair. An efficient instrument, there is no denying it, and one well adapted to the peculiar woolly fur of the Lemur. When we realise that the peculiar form of the lower front teeth of the Lemur is the result of specialisation effected for the elaboration of a hair comb, we obtain the clue to the functions of another remarkable feature of lemurine anatomy.

We have previously mentioned the little tags found within the mouth of some animals; and these little tags we have postulated as being functional tooth cleansers. The lower front teeth of the Lemur, being no ordinary teeth, but hair combs, need an extraordinary tooth brush. This tooth brush is present in the form of the remarkable development of the lemurine sublingua. Although the real use of the sublingua was probably known to many observers of animals, to science it remained a mysterious structure.

In 1918, as the result of watching Lemurs at their toilet, I published an account of the functional rôle of the sublingua. (7) When a Lemur has conducted the toilet of those parts of its body that it can reach with its dental hair comb, it rapidly moves the sublingua backwards and forwards over the comb, and with its little horny processes removes the débris from its teeth. (See Figure 6.) The woolly-

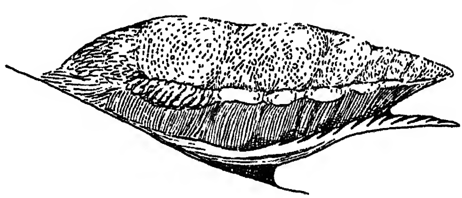

Figure 6.—The tongue of a Lemur, to show the so-called sublingua (plica fimbriata) adapted to the cleansing of the dental hair comb.

(7) *Journal of Anatomy and Physiology*, Vol. LII., p. 345-353.

coated Lemurs, which have nails instead of claws on all their fingers, and only one claw on their toes, are provided, nevertheless, with a complete hair comb and a most efficient brush for cleansing the comb.

A curious parallel structure in the nature of a dental hair comb is seen in the so-called Flying Lemur (*Galeopithecus volans*). The Flying Lemur is not a real Lemur, but it has a real dental hair comb, and this hair comb, though having the same function, is made in an altogether different way. In the true Lemurs six teeth are raked forwards so that each individual tooth constitutes a tooth of the comb; in the Flying Lemur the front teeth themselves are pectinated at their free edges, so that each individual incisor tooth furnishes many teeth for the comb. (See Figure 7.)

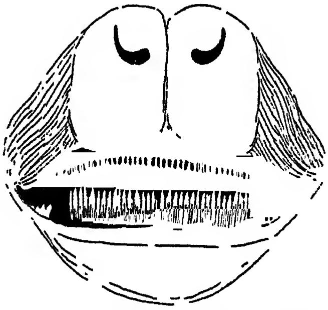

Figure 7.—The mouth of the Flying Lemur (*Galeopithecus volans*), to show the pectinated lower incisor teeth and the anterior, pectinated, edge of the tongue.

In this way there is an economy in the sacrificing of individual teeth for the composition of the comb, and in *Galeopithecus* there is no need for the canines to come forward and assume the form of incisors, but, on the other hand, they become modified in the direction of the molar series.

Just as the true Lemurs have developed their tooth brushes from the sublingua, so has *Galeopithecus* produced a harmonious structure, but it is made, not from the sublingua, but from the tongue itself. The anterior edge of the tongue of *Galeopithecus* is finely serrated, the serrations being used, so one imagines, for working in the interstices of the dental serrations, as the sublingua of the Lemurs works in the intervals between the individual teeth. I think that none would be likely to doubt this interpretation of the

Lemur's procumbent lower teeth and of its specialised sublingua. Certainly no one would doubt it had they watched a Lemur at its toilet. With *Galeopithecus*, so far as I know, no observations have been made on the living animal, and it may be that some would shrink from assigning a toilet function to the curious lower incisors, to which no other function, demanding the special development of the pectinated edge, has been assigned.

When discussing this matter seven years ago I suggested that the reason for the development of the dental hair comb and lingual tooth brush in *Galeopithecus* was to be found in the fact that its manus was hampered from performing toilet operations by reason of its incorporation in the flying membrane. At that time, not being concerned with the question of dental modifications for toilet purposes, I carried the matter no further; but it is difficult to know, to-day, just how far the matter can be carried. Take a further extension of the argument applied at that time to *Galeopithecus*. If the incorporation of the manus in a flying membrane might beget dental hair combs by reason of the manus being thrown out of toilet employment, then the Bats, one would imagine, might show some such specialisation. It may be that many mammalogists would not agree that the curious lower incisors of the *Microchiroptera*, or Insectivorous Bats, were highly specialised teeth, modified for the requirements of the toilet. We have seen that, with the development of a dental hair comb from the lower front teeth of the Lemur, the upper front teeth tend to become functionless and to undergo reduction. In the *Microchiroptera* this reduction of the upper front teeth, with the accompanying serration of the edges of the lower front teeth, is carried to extremes.

Opportunities for watching the *Microchiroptera* at their toilet are not easily come by, and it has not fallen to my lot to observe an Insectivorous Bat carry out the toilet of its coat since the peculiarities of its lower front teeth have attracted my attention. In the absence of direct observation upon this point it is, therefore, only possible to suggest—it is not possible to assert—that the curious serrated lower incisors of the *Microchiroptera* are modifications that are associated with the toilet requirements of animals deprived of the toilet uses of the manus. (See Figure 8.)

Observations on the life histories and habits of our native Bats are sadly wanting, and I would recommend to

our field naturalists the study of living Bats. If this study be carried out, I feel sure that it will be observed that some portion of the Bat's body, probably the ventral surface and the shoulders, is subjected to a combing by the curious serrated lower incisor teeth.

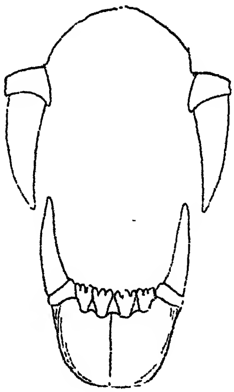

Figure 8.—The anterior teeth of an Australian Bat (*Taphozous flaviventris*), to show the pectinated lower incisors and the absence of upper incisors.

It is impossible, within the compass of this review, to deal with the innumerable possible toilet modifications of the front teeth of mammals. Only this may be asserted, that as observations on living animals are accurately recorded so will our appreciation of the front teeth as toilet implements grow.

Here we may confine ourselves to native animals upon which observations are easy to make, and concerning which assertions as to habits and structure are easy to check. The marsupial animals are traditionally divided into two sections—the *Polyprotodontia* and the *Diprotodontia*. The one section has many small front teeth, the other has few and large front teeth. There is, however, another possible division of the marsupialia into two other divisions—the *Didactyla* and the *Syndactyla*, the one section having normal pedal digits, the other having the second and third digits conjoined. With the exception of one family (*Peramelidæ*), the *Polyprotodontia* are *Didactyla*, and the *Diprotodontia* are *Syndactyla*. Put into ordinary language, this means that (with the exception of one family) all the marsupials having small front teeth have normal, simple, digits, whilst all the marsupials

having few and large front teeth possess the specialised syndactylous pedal digits. Surely there must be some underlying correlation in this. The syndactylous pedal digits seem to be begot when the front teeth become few. As we shall see later, the syndactylous pedal digits constitute an undoubted toilet implement. Do they then replace the many small front teeth which are themselves toilet implements? From observations on living polyprotodont didactylous marsupials I certainly think this is so. I have come to regard the specialised incisors of the *Didactyla* as being toilet modifications, and this as a consequence of repeated observations of their use for the purposes of the toilet. To this subject I have already called attention (8), and here it is only necessary to recapitulate, in a brief manner, the results previously recorded.

I have had examples of Krefft's Pouched Mouse (*Dasycercus cristicauda*) under close observation for upwards of four years, and the detailed toilet of the coat has been repeatedly witnessed in these animals. (See Figure 9.)

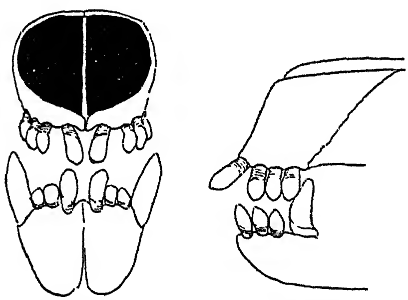

Figure 9.—The front teeth of Krefft's Pouched Mouse (*Dasycercus cristicauda*), showing the specialised central incisors.

These attractive little marsupials scratch themselves vigorously with the digits of the pes; but if any part of their body demands special attention they turn their heads and nibble and comb their hair in a very characteristic fashion. From these observations I have been for some time convinced that the front teeth and the syndactylous digits were complementary structures, vicariously discharging the same functions; and have already suggested that the little sharp front teeth of certain other animals are probably of more importance as toilet implements than as organs connected

(8) *Mammals of South Australia*, 1924, Part II., p. 135, and *Trans. Roy. Soc. South Aust.*, Vol. XLVIII., p. 187, 1924.

with alimentation. It is only of late, however, that, in watching *Dasycercus* at its toilet, I have come to realise that there is a remarkable specialisation of its front teeth, which is, as far as I can determine, related solely to the function of hair combing. Of the eight incisors carried in the upper jaw, two, the central members, are in every way abnormal. These two teeth are remarkable, not only in their form, but in the axis in which they are carried in the jaw, for they rake forward at an agle which carries them out of alignment with all the rest of the teeth. So marked is this projection of the upper central incisors that, in the normal position of the jaws, they do not articulate with the corresponding members of the mandibular series. The upper central incisors are large teeth, larger and longer than their fellows, from which they are separated by an interval which exceeds their own diameter. They are also separated from each other by a slightly smaller interval in the mid line, and at their tips they somewhat tend to approach each other. The corresponding lower central incisors are also specialised, being considerably longer and larger than their fellows, and separated from each other in the mid line by an interval similar to that which separates the incisors of the upper jaw. When the jaws are opened and shut it will be seen that these specialised front teeth do not bite together as the other incisors do, but the lower centrals close behind the upper centrals, their "occlusal" surfaces failing to articulate. It is impossible, after having watched the animal at its toilet, to avoid the conclusion that these specialised, projecting incisors, separated by a median gap, are the functional counterpart of the little parallel claws of the syndactylous pedal digits. Indeed, it is difficult to postulate any other function from them.

Dasycercus is not the only didactylous didelphian exhibiting this specialisation of the anterior teeth, for, with the exception of *Sarcophilus*, all the species that I have been able to examine show the peculiarity in some degree. The various members of the genus *Phascogale* display the long, projecting, upper central incisors in a still higher degree of specialisation, and the condition is well seen in *Phascogale penicillata*. (See Figure 10.)

In the Native Cats the differentiation of the front teeth is not so pronounced, but, nevertheless, the peculiarity is quite obvious, for the upper central incisors cant forwards and are separated from each other and from their fellows.

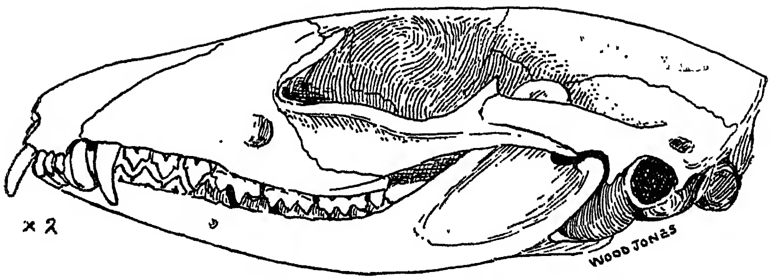

Figure 10.—Skull of the Brush-tailed Pouched Mouse (*Phascogale penicillata*), to show the projecting upper central incisors.

The lower central incisors are also large, distinct in form, and separated in the mid line.

Perhaps the most interesting modification of the anterior teeth is that seen in *Myrmecobius,* for here it is the lower incisors that are the most highly specialised, the upper central incisors being very small, but sharply pointed. In *Myrmecobius* the teeth are more widely separated in the mid line than they are in the Pouched Mouse, and it is to be hazarded if this modification is associated with the coarse, hispid hairs which constitute the animal's coat. The lower central incisors of *Myrmecobius* are relatively very large teeth, and are peculiar in their form. The special interest attached to these teeth of the Numbat lies in the fact that the dentition of the creature is obviously in a state of degeneration. In the midst of this degeneration the two lower central incisors stand out in marked contrast, and it might almost be said that they are practically the only undegenerate teeth that the animal possesses. (See Figure 11.)

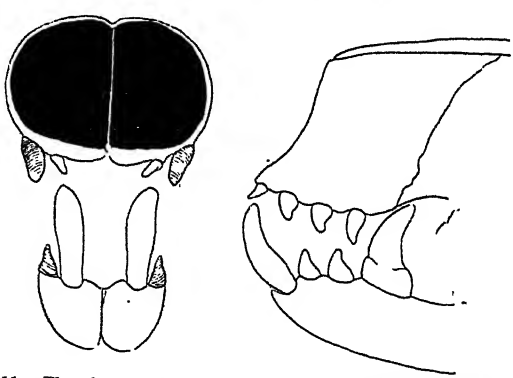

Figure 11.—The front teeth of the Banded Ant-Eater (*Myrmecobius fasciatus*), to show the specialised lower central incisors.

From the refined toilet of the coat by the dental hair comb of the Lemur to the casual nibbling at the site of the operations of an importunate flea, as witnessed in the dog, there is evidently a gradation in the toilet usage of the front teeth in the mammals. There still remains the question of the correlation of the two divisions of the Australian marsupials into the *Polyprotodontia* and *Diprotodontia* and the *Didactyla* and the *Syndactyla.*

We have seen that all the Australian marsupial animals, with the exception of the family *Peramelidæ*, which possess many small front teeth, have no specialisation of toilet digits on the pes, and that all the Australian marsupial animals possessing few and large front teeth have, without exception, the specialised syndactylous toilet digits.

The *Peramelidæ* (Bandicoots) are, therefore, in an anomalous position, for they have many front teeth and also possess the specialised pedal toilet digits. It is true that the Bandicoots possess the many front teeth, they have five upper and three lower incisors upon each side of the jaw, but the incisors are no longer of the type seen in the rest of the Polyprotodonts; they have lost their pointed, prong-like character, and have become chisel-shaped. It is not, therefore, the quantity of front teeth, but the quality of them which determines their use as toilet implements. The *Peramelidæ* have many front teeth, but these front teeth, being useless for the toilet of the coat, have been supplanted by the syndactylous toilet digits of the pes.

(7) BY BRUSHING WITH A SPECIALISED HAIR BRUSH.

How common mammalian hair brushes are, and upon what parts they may be developed, I do not know, but when we take into consideration the perfection of one of these organs it seems not unlikely that others, possibly less perfect, exist.

An excellent account of the toilet of a Free-tailed Bat—*Nyctinomus brasiliensis*—was published in 1865. The description was written by Mr. W. Osborn in Jamaica. Referring to the toilet of the Bats, he says: "The luxury King "James thought too great for subjects, and ought to be "reserved for kings, is largely indulged in by Bats. First "one and then another wakes up, and, withdrawing one leg "and leaving himself suspended by the other alone, adroitly "uses the foot at liberty as a comb, with a rapid effective

"movement dressing the fur of the underpart and head—an "action far from ungraceful. The foot is then cleaned "quickly with the teeth or tongue, and restored to its first "use. Then the other leg does duty. Perhaps the hairs with "which the foot is set may add to this end. I often have "seen them do this in confinement; and probably the numerous "Bat-flies with which they are infested may be the cause "of extra dressing." The suggestion that the hairs that spring from the lateral digits of the pes aid in carrying out the toilet of the coat is, so far as I know, the first allusion to one of the most remarkable toilet appliances seen in the mammals. Among the distinguishing features of the Molossine Bats is the character that "the feet are broad, the "outer and inner toes much thickened and larger than the "others, and furnished with long curved prehensile hairs." (9) I think it would be a mistake to suppose that these hairs had a prehensile function. No hint of their being useful in this way can be gleaned from watching living examples of our common Molossine Bat—*Nyctinomus australis*—but on the other hand this Bat will readily demonstrate the truth of Osborn's observations on the Jamaican member of the Genus.

In some Bats the brush is confined to the first digit only, and then this digit is considerably stouter than any of the others; in our Free-tailed Bats the marginal digits, the first and the fifth, are both thickened and both furnished with brushes. The brush is a complex and beautiful structure. The hairs composing it are stiff and bristle-like, and each is crooked at its tip. The hairs project from the margin of the first and fifth digits, and are so arranged that their free extremities all end on a common level, the outer hairs being longest, the inner ones shortest. The recurved tips of the hairs are a striking peculiarity, for each bristle is bent at a right angle just short of its tip. (See Figure 12.) The little hooked ends of the hairs are so arranged that the free tips are directed towards the middle line of the foot. In this way the little brush functions somewhat after the fashion of a rake, and after it has been passed through the soft fur it leaves its furrowed imprint clearly defined.

Probably this molossine hair brush is not unique in the mammals, and it is to be noted that, in the sense that it is a flange added to the side of a digit, it somewhat recalls the

(9) Dobson, G. E., *Catalogue of the Chiroptera in the British Museum*, 1878, p. 403.

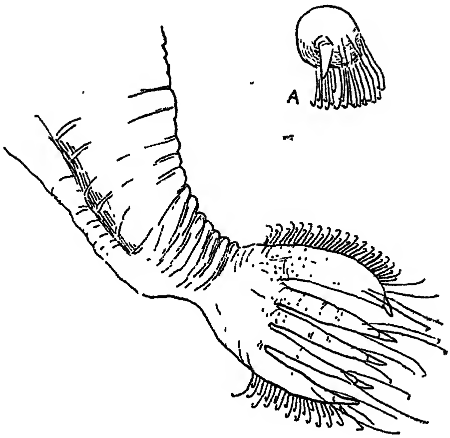

Figure 12.—The pedal hair brush of a Free-tailed Bat (*Nyctinomus australis*), which inhabits Australia and Tasmania.

avian pectinated preening claw which has recently been thoroughly re-investigated in Australian birds by Dr. A. M. Morgan. (10) It is of interest that in Osborn's account of the use of this hair brush the teeth or the tongue are ultimately called upon to cleanse the brush. Here again is seen the sequence we noted in the Lemur; the specialised toilet implement needs a mechanism for its own cleansing.

(8) BY SCRATCHING OR COMBING WITH NAILS OR CLAWS.

Here we may encounter mere generalised scratching, with claws not specially modified for this purpose, or we may meet a deliberate toilet carried out by a definite toilet implement fashioned from claws specialised for this purpose. Of the general use of the human nails for the purpose of the toilet an anonymous author wrote in 1724 (11) :— "A further Use of the Nails is, that they, like Hooks, are "serviceable in drawing anything to us, and are Weapons "to defend us from the Trouble that arises to us from some "small living Creatures that often make their Habitation "upon the Surface of our Bodies, and to allay the uneasy "Titillation by scratching."

(10) The Pectinate Middle Claw in Australian birds, *South Australian Ornithologist*, Vol. VIII., part 2, March, 1925, p. 44.

(11) *An Essay concerning the Infinite Wisdom of God, manifested in the Contrivance and Structure of the Skin of Human Bodies.* By a Lover of Physick and Surgery. 1724. p. 9.

Although we have seen that in certain very remarkable directions our several fingers are allotted separate toilet offices, nevertheless, all unite in discharging the general business of body scratching when this scratching is done on a large scale. But for what might be termed precise and localised scratching the index finger is the elected member. In many other animals this election and specialisation of a scratching toilet digit goes much further, and a definite toilet implement is begot. It is impossible here to trace the office of the nails as toilet implements through the whole of the mammalia, a vast amount of observation must be carried out and recorded before the facts are available. We must content ourselves with noting one or two outstanding examples among the higher mammals, and then confining our attention to the Monotremes and Marsupials where assertions as to behaviour and the use of toilet digits may readily be checked by watching the living animals.

We have previously noted the dental hair comb of the Lemurs; but this is not their only toilet implement. They possess a pedal hair comb also. Lemurs are peculiar in that though flat nails are developed on all the digits of the manus and on four digits of the pes, the second pedal digit bears a strong erect claw. Of *Lemur mongos* Cuvier recorded (12) :—"Nous ne les avons jamais vus se serve de cet ongle à autre "chose qu'a l'introduire dans leurs orielles." This strange nail may, therefore, function in the special toilet of the ear as well as in the wider office of tending the general coat toilet. (See Figure 13.)

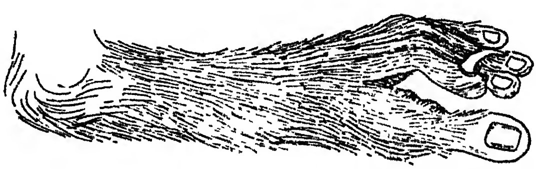

Figure 13.—The pes of a Lemur, to show the only claw—that of the second pedal digit—the animal possesses.

One of the most remarkable toilet digits, the function of which seems to have had little attention devoted to it, is the greatly elongated claw of the second pedal digit of *Echidna*. That the great claw is a toilet implement there is no doubt;

(12) *Op. cit. sup.*, p. 214.

it is begot for scratching down to the roots of the spines, and the length of the claw is in proportion to the length of the spines. In the very much larger and longer spined race of *Echidna*, which lives in the South-eastern portion of South Australia, the claw of the second pedal digit is harmoniously enlarged. In the small-spined form of *Echidna* that inhabits Kangaroo Island the toilet digit measures 35 mm., while in the long-spined Southern South Australian form it has increased to 50 mm. (See Figure 14.)

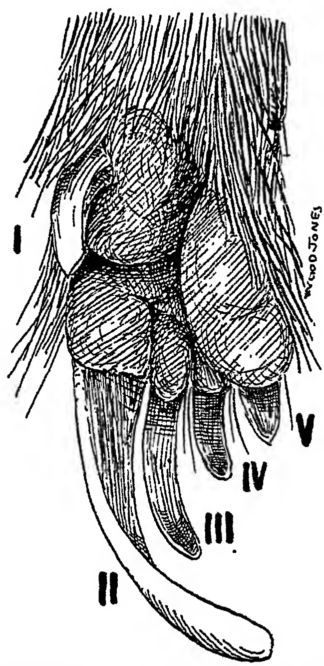

Figure 14.—The enlarged claw of the second pedal digit of the common Spiny Ant-eater (*Echidna*).

It is to be noted that the pedal toilet digit of *Echidna* is the same member of the series as that of the *Lemur;* and we may make a generalisation and say that the hall-mark of pedal toilet digits is that they tend to be on the inner side of the foot and on the inner margin of the digit. This is the side of the foot and the side of the digit most readily brought into apposition with the body in performing what may be called the down stroke of scratching. The

pectinated claw of the birds follows the same rule. With most animals the first pedal digit is too valuable for its own sake to be given over to the toilet, and the second accepts the office. But where the first digit has lost this value, as in the Bats, it becomes the toilet digit of the pes, and in certain Bats an exceptional implement is placed on the fifth digit; Bats being apparently capable of passing their feet over parts of their body in both directions with equal effect, or of performing up stroke, as well as down stroke, scratching.

It is not always the second pedal digit only that takes over the functions of the toilet when the first is too valuable to be spared for this purpose. The second and third pedal digits may both be set aside for this function. In the true Lemurs the second pedal digit alone bears a claw, but in that Lemur, which is no Lemur—*Tarsius spectrum*—the second and third pedal digits are clawed, whilst all the rest have flat nails. Fortunately we have accurate observations upon the use of these toilet digits of *Tarsius*. (See Figure 15.)

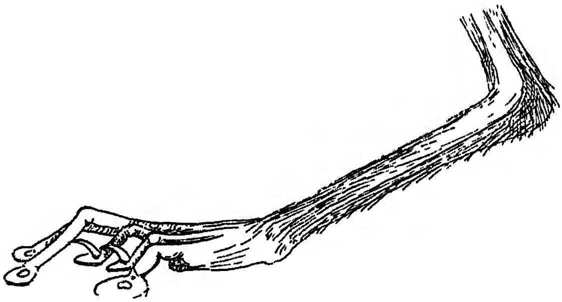

Figure 15.—The pes of *Tarsius spectrum*, to show the second and third pedal digits, which both bear claws.

It is also the second and third pedal digits that are involved in that most interesting of all digital toilet implements—the conjoined pedal digits of the syndactylous marsupials. In 1839 Sir Richard Owen wrote of these peculiar little toes that "they look like little appendages at the inner "side of the foot for the purpose of scratching the skin and "dressing the fur, to which offices they are exclusively de- "signed." (13) No better statement could be made con-

(13) In Robert Todd's *Cyclopedia of Anatomy and Physiology*, 1839-1847, Art. Marsupialia, p. 286.

cerning their structure and function, nevertheless Owen's clear pronouncement—like so many of his dicta—has often been overlooked. We cannot pretend to approach any more nearly to accuracy by adopting Pocock's more recent

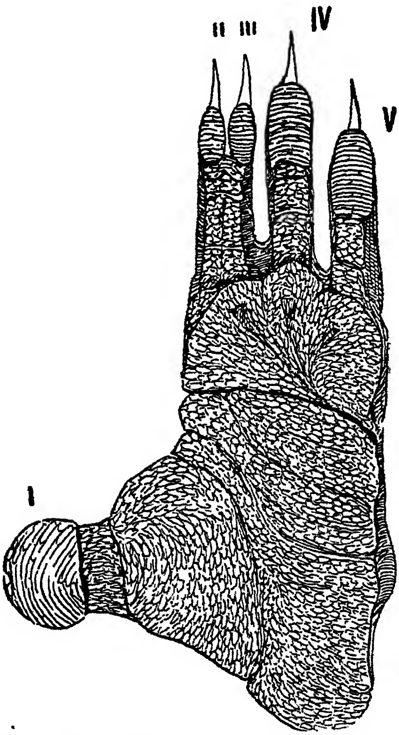

Figure 16.—The pes of the Native Bear (*Phascolarctus cinereus*), to show the elongated syndactylous second and third digits.

suggestions (14) that in *Phascolarctus* they are sufficiently well developed to assist in climbing, and in *Phascolomys* are large enough to be subservient to digging. It is enough to

(14) *Proc. Zool. Soc.*, 1921, Part III., p. 602.

know that they are used in the toilet and not in climbing or digging; that they are large enough to be used in either of these latter processes is a piece of information of no importance. That our hands are used for a variety of refinements of function is interesting, that they are large enough and strong enough to support the body weight in quadrupedal progression is no sound argument that their use lies this way. Pocock's reference to the function of the syndactylous elements of the Marsupial foot is added to this 1921 paper in the form of a footnote. In 1920 I had named the syndactylous digits as "toilet digits" in a paper dealing with the Common Opossum (*Trichosurus vulpecula*) (15), and at the time was unaware of Owen's previous dictum.

The correctness of this designation of them, and the truth of Owen's original assertion that to "these offices they "are exclusively designed" is confirmed by every observation that I have since made.

The syndactylous pedal digits of the Marsupials are definite hair combs, put to no other use whatever. They are not degenerate or rudimentary digits; they are highly specialised and highly functional members adapted to the single end of being fitted to comb the particular type of hairy covering possessed by the animal. Just as the toilet nail of *Echidna* varies in development with the growth of the spines, so those marsupials which possess long woolly or hairy coats have elongated syndactylous digits, whilst those with short coats have the elements far less developed. (See Figures 16 and 17.) We may contrast the elements in the long woolly coated Native Bear with those in the short smooth coated Red Kangaroo. Not only are they specialised toilet digits, but, as we have seen, there is reason to believe that they are begot when, in response to a change of diet, the many little sharp front teeth are replaced by few and larger chisel-shaped teeth. To those who have opportunities for watching Marsupials there is no need to dwell further on the matter. The wonderful mobility and aptitude of this little instrument are so easily observed in living animals that half an hour of observation will teach more than the reading of many books.

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(15) *Trans. Roy. Soc. South Aust.*, Vol. XLIV., 1920, p. 372.

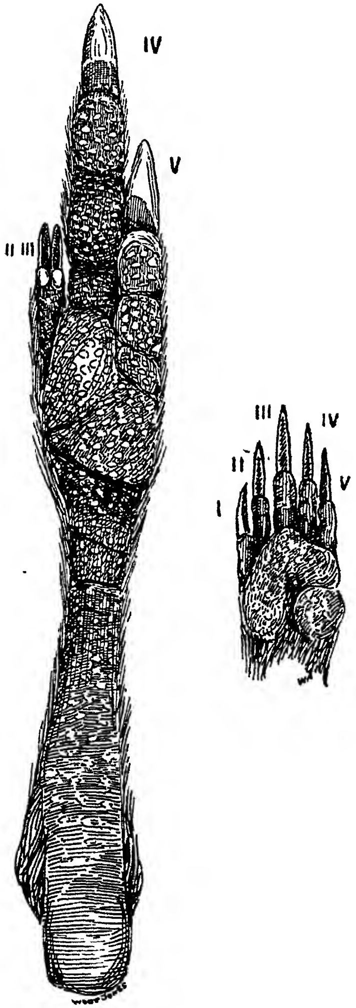

Figure 17.—The pes of the Dama Wallaby (*Thylogale eugenii*), to show the short syndactylous second and third digits.

MANUS SCRATCHING OR PES SCRATCHING.

With which member does any particular animal conduct its coat toilet? All of us have certain generalised pictures of animals scratching themselves; but it is astonishing how few printed records there are of the actual operation. We know that a dog scratches itself altogether with its pes; we know that a cat cleans certain parts of its body with its manus, others with the tongue directly, and that it seems to confine scratching with the pes to its "ticklish" spot at the base of the ears. We know that a monkey conducts the toilet of its whole body or the body of its neighbour with its fingers, and here let it be definitely laid down that a monkey's digital toilet is a pure skin and coat toilet, and is not, as is so commonly assumed, an unending pursuit of parasites. Monkeys are pre-eminent among the mammalia for being free of ecto-parasites. There is no such thing as a monkey flea or a monkey with fleas.

After prolonged investigations upon all the monkeys dying in the gardens of the Zoological Society of London, careful search for parasites proved vain until the arrival of a consignment of closely packed, ill-conditioned monkeys, that, during their long journey in overcrowded cases, had become infested with a *pediculus*. The ordinary monkey that is so assiduous in its toilet has no parasites to capture, and it will apply the process to a human hand and arm with as much zest as it displays in the case of its neighbour or itself.

In the case of that most interesting of the Primates—*Tarsius spectrum*—we have, thanks to Professor Le Gros Clarke, (16) an accurate description of the toilet, for he says:—"The hind limb is used for scratching purposes, the "digits of the pes being flexed on the sole in such a way that "only the two claws on the second and third digits are left "protruding." This animal also conducts its toilet with its tongue "by licking the fur after the manner of a cat." With the great majority of the higher animals we need more extensive study and a better recorded series of observations. One little detail may, however, be recorded. During the stay of a party on Pearson Island in January, 1922, all the members were much struck with the ability of the otarid Hair Seals to scratch themselves over a large area of the body with the nails of the pes, when the flipper membrane was flexed from the free extremities of the nails. The

(16) *Notes on the Living Tarsier, Proc. Zool. Soc. Lond.*, 1924, p. 219

toilet of these Sea Lions is conducted with the nails of the pes, and a long-continued and oft-repeated toilet it is. The interest of this toilet of the Seals lies in the fact that the phocid Seals are unable to conduct a pedal toilet, since their hind limbs are permanently turned backwards as the tail flipper. In the Phocids then, the limited toilet is conducted by the claws of the manus. This example of the toilet of the two divisions of the *Pinnipedia* is of interest, for it shows us that a vast number of observations must still be made and recorded upon the toilet methods of the higher mammals. In the case of the Monotremes and Marsupials we are on more certain grounds. I think that none will dispute the pedal toilet of the bristles conducted by *Echidna*; certainly no critics will arise from the ranks of those who have ever given room to this most difficultly housed and most tiresome of pets. With *Ornithorhynchus*, however, the case is very different. Dr. George Bennett made many observations on the toilet of the Platypus, and nowhere in his writings can I find any reference to the employment of the manus as a toilet implement. (17) In his numerous admirable accounts he always mentions the employment of the pes; he notes that the toilet of the coat is an oft-repeated affair, and he makes several references, of which the following may be taken as typical:—

(1) *Op. cit.*, p. 119. "In this process of cleansing the "skin the hind claws were brought into use—first the claws "of one hind leg, then those of the other; but finding that "it could not use the one to which the string was attached so "well as the other, which was disengaged, after repeated "trials it gave up the attempt. The body being so capable "of contraction, was readily brought within reach of the "hind feet, the head also coming in for its share of the pro-"cess." (2) On page 143 he records that they "reclined on "one side, scratching themselves with the hind claws." (3) He also noted, p. 135, that, "besides combing their fur to "clean it when wet, I have seen them preen it with their "beak (if the term may be allowed) as a duck would clean "its feathers."

Dr. Bennett, we may therefore conclude, noted that the coat toilet was conducted with the pes, aided by the occasional preening with the "beak." That the coat toilet should be conducted by the pes we would expect from the anatomical

(17) *Gatherings of a Naturalist in Australia*, London, 1860.

conditions displayed in the manus and pes respectively, and also from a general knowledge of the use of the pes and manus in early mammalian forms.

Of late, however, a disturbing note has crept in, for Mr. Harry Burrell (18) has declared for the manus toilet of the Platypus. In that paper he says:—"Having studied "the Platypus in captivity as well as in its natural haunts, "I am convinced that most of the principal duties are per- "formed with its active and powerful fore-limbs" . . . . "in grooming or scratching itself, this quaint contortionist "squats 'tripod fashion' on its haunches, and imitates every "antic peculiar to a flea-infested monkey."

It must be remembered that Burrell is here attempting to establish the thesis that the soft, rubber-like hands "are "used for manipulating the eggs." It is possible that they are. But are the "soft, rubber-like hands" used for the toilet of the fur, as he describes, to the exclusion of the better adapted pes, as Bennett maintained? It can only be said that anatomical probability supports Bennett's observations, but that wider and more extended observations are needed to settle the point. Meanwhile, we may safely affirm that when Burrell likens the Platypus to a "flea- "infested monkey" he may be making genuine and astute observations on the Monotreme, but he does less than justice to the Primates. It must not be forgotten in this connection that even the spur of *Ornithorhynchus* has been deemed a toilet implement.

Of the *Didelphia*, I have watched many species at their toilet. Of the Didactylous forms, all the species that I have had under observation, including various Pouched Mice and Native Cats, have conducted the coat toilet with the pes, aided by the teeth. All scratching is done with the foot, and the manus is never employed in this occupation. With the *Syndactyla* the methods vary. I have had several members of the *Peramelidæ* living in captivity, and all of them, from the Short-nosed Bandicoots (*Isoodon*) to the Bilbies (*Thalacomys*), employ the pes only, aided by an occasional nibble with the front teeth. So great is their reliance on the pes for the performance of the coat toilet that one Bilby (*Thalacomys nigripes*), which lived for long in captivity and had suffered the loss of a hind leg in a steel rabbit trap, made vigorous efforts to scratch with its stump, but never

(18) *The Australian Zoologist*, Vol. I., Part 1, 1917, p. 87.

replaced the office of the absent pes by attempting to employ the manus. Most of the *Phalangeridæ* employ the pes for the regular coat toilet, but in many of them the manus has a limited and occasional use over a restricted area of the body. The members of the *Macropodidæ* vary in their usage. The only member of the *Potoroinæ* that I have had under observation is *Bettongia lesueuri grayi*, and this animal I have never caught employing the manus in its toilet. Many examples of this species I have had under observation in captivity for several years, but since they are nocturnal in their activities they are not easy to study. Nevertheless, as the pedal toilet has been witnessed on many occasions, it is safe to say that if the manus is used for this purpose at all its employment is no regular thing. Among the *Macropodinæ* there is also a difference in individual methods, for though the manus toilet is only a very occasional affair in the little Wallabies of the Dama group, it is a constant and regular proceeding with some of the larger Wallabies and with all the Kangaroos that I have observed. In all the Kangaroos the manus and the pes are employed each for its special office in the toilet, and herein lies the interest in the study of these animals.

It is much to be hoped that all field naturalists who have opportunities for observing animals at their toilets will record their observations, for so many intimate details are lacking in our knowledge of these habits of even the commonest animals.

THE SPECIAL NEED FOR TOILET APPLIANCES IN CERTAIN ANIMALS.

We have seen, even within the limits of this very partial survey, that whereas some animals possess well defined toilet appliances, some are apparently not so well endowed. It may be asked, why are some animals so lavishly supplied whilst others apparently go lacking? In the first place we may be fairly sure of our ground when we assert that if an animal retains fairly generalised digits such as are possessed by the higher Primates, toilet appliances will be few. The nimble, resourceful, inquisitive fingers have supplanted the specialised toilet implements.

But suppose the digits become so altered that they are useless for the performance of the toilet, then there is need for specialisation. This is the case with the Bats, and in

lesser degree, with the Flying Lemur, which, as we have seen, possess such cunningly contrived toilet appliances.

Into this category fall most of the *Ungulata*, and in them there seems to be but little provision made to compensate for the loss of the individual digits. *Ungulata* must use their tails, their horns, even their hoofs, and over certain areas their tongues. They must rub against external objects, roll in herbage, wallow in the mud, or, in extremities, resort to a bath.

Then, again, the texture of the coat has to be considered; and here the *Ungulates* are compensated by nature, for most of them have coats which do not require an elaborate toilet, and some are practically naked. Nevertheless we may note here that when, by artificial selection, man develops an abnormally thick coat, which requires a toilet, on an *Ungulate* that cannot conduct the toilet, disaster is likely to occur. We rightly blame the blow fly for the havoc it plays among sheep; but we must not overlook the fact that we have developed for commercial purposes a coat which needs a toilet on an animal which is incapable of carrying out the toilet. Another consideration is also of importance. Just as, according to the anonymous writer of 1724, our finger nails were provided as weapons against the small creatures which pestered us, so are the toilet digits of the mammals adjusted to their prevalent ecto-parasites. Osborn noted in connection with the toilet of the Jamaican *Nyctinomus* that "probably the "numerous Bat-flies with which they are infested may be "the cause of extra dressing." These ecto-parasites of the Bats are peculiar creatures and the *Nycteribiidæ* infesting Australian bats have recently been reviewed by Musgrave, of Sydney. (19)

I have elsewhere alluded to the importance of the Marsupial parasites known as *Mallophaga* or Biting lice. (20) These parasites have been studied by Launcelot Harrison and Harvey Johnston, (21) and their presence in the coats of the Marsupials possibly accounts for the need of the elaborate Marsupial toilet. The study of Mammalian ecto-parasites and mammalian toilet mechanisms is one which stands in need of correlation. But it is not to be doubted that the parasite is to be considered in the question.

(19) *Records of the Australian Museum*, Vol. XIV., No. 4, 1925, p. 289.
(20) *The Mammals of South Australia*, 1924, p. 135.
(21) *Parasitology*, Vol. VIII., No. 3, 1916, p. 338.

THE MAMMALIAN COAT.

So much for some of the numerous ways in which the mammals conduct the toilet of the coat, and for some of the factors which demand the creation, and determine the type, of the special toilet implements.

It is necessary, as a further step in this study, to examine what may be described as a typical mammalian coat. For this purpose we may select a primitive member of the *Didelphia* and Krefft's Pouched Mouse (*Dasycercus cristicauda*) provides an admirable example of such an animal. (See Figure 18.) In the adult animal the fine

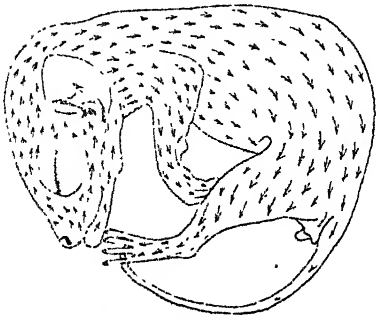

Figure 18.—Pouch young of Krefft's Pouched Mouse (*Dasycercus cristicauda*), to show the primitive type of hair tracts.

soft hair lies smoothly all over the body, and the tips of the hairs are all directed backwards, so that the animal can be stroked from head to tail in order to smooth its hair. We can learn more when we examine an immature young animal upon which the hair is only just beginning to appear. In such a specimen the direction of the short hairs is readily detected, since each individual hair is short and stiff, and is like a nail driven obliquely into a piece of wood. The hair is not yet long enough to have its direction altered by brushing or parting.

It must be insisted here that the study of hair direction can only be undertaken properly upon such young animals, and that it is much to be desired that hair charts of suitable specimens should always be recorded. Accounts based on the examination of living adults may also attain to a high degree of accuracy, but descriptions written from skins or from prepared or mounted specimens are likely to be extremely misleading.

In *Dasycercus* the hairs of the muzzle and chin point directly backwards, and those of the face, running to the anterior angle of the eye, part into two slightly curved streams, which run around the eye and meet again at the front of the ear. Upon the head and neck, the chest, and the whole of the back, sides, and ventral surface of the body the hairs are pointed with their free tips directed backwards and slightly downwards. Along the tail the hairs follow the same direction, pointing to the tip. Upon the backs of the ears the hairs stream from the sides of the head, and are directed towards the tip of the auricle. On the limbs, the hairs point downwards from the body to the digits and also backwards from the front (pre-axial) aspect of the limb to its hinder (post-axial) aspect.

This may be taken as the picture of the primitive hair pattern of the mammal, and it may be summed up by saying that the hair is directed caudad and ventrad upon the trunk and distally and post-axially upon the limbs. Among the primitive Marsupials that present this simple type of hair pattern we may mention the Banded Ant Eater (*Myrmecobius fasciatus*), the Native Cats (*Dasyurus*), and the Tasmanian Devil (*Sarcophilus*), as well as the little Pouched Mice, of which we have taken *Dasycercus* as an example.

Besides these marsupial animals, the primitive hair pattern may be seen in a large number of less specialised higher mammals. But the primitive hair pattern is upset in some way or another in many types, and these upsets lead to the development of the well-known hair tracts.

HAIR TRACTS AND THEIR CAUSATION.

It is well known that whilst some animals have a uniformly directed hairy coat, others show partings, whorls, convergences, and reversals in certain areas of their bodies. Everyone is familiar with these things upon the coats of domestic animals or even the poorer manifestation of them, upon the hairy covering of man himself.

Why is the hair of some animals arranged in the pattern of basal mammalian simplicity, and how are any alterations in this basal simplicity effected in those animals showing departures from the primitive mammalian type? At once we encounter theories, and many such have been put forward to account for the varying hair trend in the mammals.

When once the hair trend has been altered from the primitive caudad, post-axial, direction, many factors might possibly be invoked to account for this alteration. We may summarise those that have been suggested as follows:—

Schwalbe, who studied the question exhaustively, postulated that, for the most part, body contour and the stretching of skin during growth accounted for the disposition of the hair. Voigt had previously put forward very much the same explanation; for he imagined that the course which the enlargement of the body takes, in the early stages of development, produced that stretching of the skin which caused the hairs to slope in different directions. Eschricht believed that the alteration of hair pattern depended upon the distribution of the vascular system. Thompson, who looked at the matter from an altogether different angle, broke fresh ground when he postulated a functional cause in the necessity for offering the least resistance to the air, to grass, brushwood, and other obstacles through which the adult animal moved. It was Thompson who also enunciated the watershed theory which found expression in the work of Darwin and subsequently of Leonard Hill. Dr. Walter Kidd followed Thompson in the upholding of external causes, these external causes being gravity, posture, movement, and the habits of the animal. (22)

Lastly, in 1924, Bolk, of Amsterdam (23), rejected all the findings of Kidd, and returned to the internal causation, which he imagines rather vaguely to be "certain conditions "of the growth of the skin." It is difficult, at first sight, to understand why the very simple explanation put forward, for some cases by Thompson and for others by Kidd, did not at once gain practically universal acceptance. Any one, who is an observer of living animals, could appreciate the fitness of the explanation when applied to certain hair tracts, no matter if its correctness did not seem to be revealed by all. On the other hand, even the advocates of the contour, stretching, and growth theories do not appear to have a clear notion of the actual production of any individual hair tract, and, for one who is not an advocate, it is a difficult matter to picture the processes involved.

When the primitive hair trend is upset, it may merely be modified or slightly distorted, obviously by the dictates of the proportions and contours of the body; or it may be completely reversed.

(22) *Initiative in Evolution*, 1920.

(23) *Journal of Anatomy*, Vol. LVIII., Part iii., p. 206.

It is those cases in which there is a complete reversal of hair trend that are most likely to reveal the causation, since, in order to turn the hair stream into a direction directly opposite from that which is primitive, the causal factor must be potent and probably the more easily discernible. In studying these reversals we will mainly confine our attentions to the Marsupials, since in them our opportunities for observation are so much more extensive and our conclusions the more easily checked.

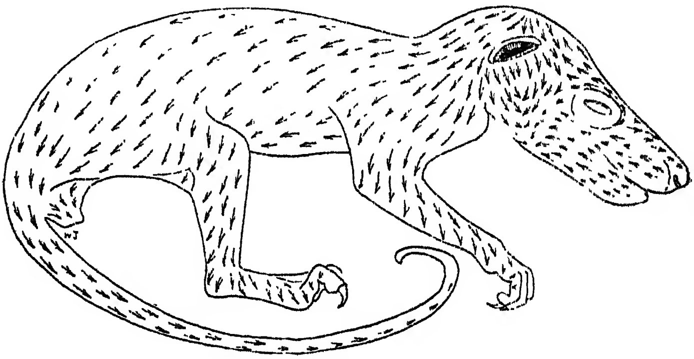

Figure 19.—Pouch young of the Rock Opossum (*Pseudochirops dahli*), showing pes reversal on the side of the head, and the preocular reversal in front of the eye.

The first striking reversal of hair trend to be noted in the Diprotodonts is that tract which involves, as a rule, the vertex of the head, the forehead, and sides of the face. A simple example of this may be taken from *Pseudochirus* or *Trichosurus*. As seen in these animals, the reversal area starts at a whorl situated somewhere on the crown of the head and, from the whorl, the hair radiates (1) straight forwards along the forehead, (2) downwards and forwards to the posterior angle of the eye, (3) directly outwards to the dorsum and posterior surface of the large ears, and, at its hinder limit, becomes normal by merging with the unreversed nuchal stream.

The making of this area I have watched repeatedly, and, from the experience thus gained, have no hesitation in affirming it to be caused by the scratching of this region, in a direction reversed from the normal hair trend, by the syndactylous toilet digits of the pes.

If *Trichosurus* be watched at its toilet it will be seen that, when it scratches itself with its hind limb, the syndactylous hair comb is raised to the anterior part of the body and the hair comb comes in contact with the animal's vertex in the neighbourhood of the whorl. From this point, at which it starts its work, it scratches the hair forwards to the forehead, forwards and downwards to the eye, and outwards on the ears. The anterior limit of this reversed tract marks the forwards sweep of the syndactylous digits as they pass down the face behind the eye. This reversed tract, made by the forward combing of the pedal syndactylous digits, I have termed the *main area of pedal reversal.* Now it is manifest that this area, if caused by pedal reversed scratching, would be liable to some variety in its exact position; for, depending upon the relative proportions of the hind limb and the trunk, there will probably be a variation in the exact area of the body accessible to pedal scratching.

In most Marsupials the caudad limit of the area is in the neighbourhood of the vertex; it may, however, extend back to the occiput, to the nuchal region, or even (in *Phascolarctus*) to the scapular region. (See Figures 20 and 21.)

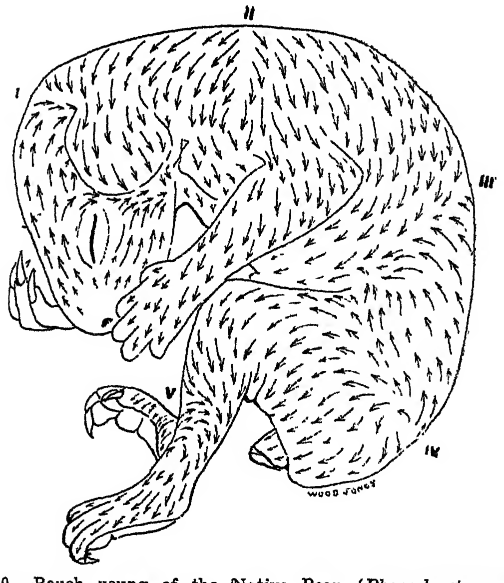

Figure 20.—Pouch young of the Native Bear (*Phascolarctus cinereus*), showing pes reversal, I.-II., and manus reversal, III.-IV.

In *Phascolarctus* the area is extremely large, and it extends from a whorl situated in the middle line of the back over the shoulders, to the crown of the head just anterior to the ears. In all the species that I have examined, so far, the area takes caudad origin in a single middle-line whorl. In

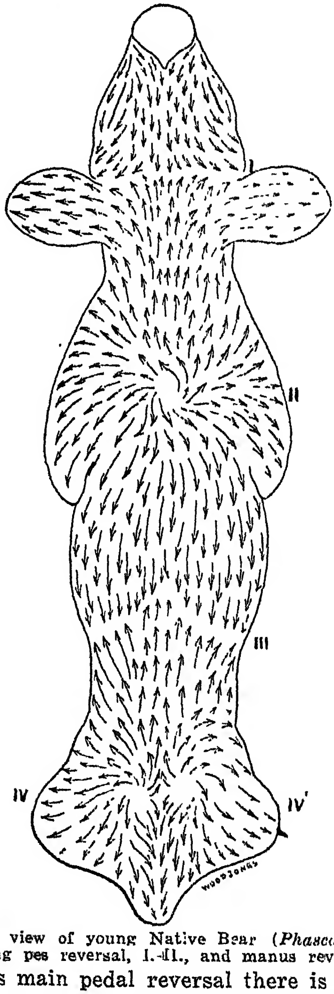

Figure 21.—Dorsal view of young Native Bear (*Phascolarctus cinereus*), showing pes reversal, I.-II., and manus reversal, III.-IV.

addition to this main pedal reversal there is a smaller and less constant reversal area, which is almost certainly caused by the reversed scratching of the syndactylous pedal digits. This area is situated upon the muzzle in front of the eyes, and is best termed the *pre-ocular reversal*.

So far as I know, no animal, in scratching its head and face, includes the actual area of the eye in its field of operations. The eye is avoided, and the combing digits pass downwards from the crown and ears behind the posterior canthus of the eye, to start operations again between the anterior canthus and the rhinarium.

Regarded in this way the pre-ocular muzzle reversal and the main pedal reversal may be regarded as being constituent parts of a single field interrupted by the presence of the eye. The pre-ocular reversal has been noted, so far, only among the *Phalangeridæ*, and it is well developed in *Pseudochirus* and in *Trichosurus*, but is not present in *Phascolarctus*.

In addition to scratching with the specialised digits of the pes, many Marsupials systematically scratch their coats with the digits of the manus. This habit is especially well marked in the *Macropodidæ*, but it is also typical of *Phascolarctus*, and probably of other Marsupials not yet studied.

In the business of conducting the coat toilet by the manus, a fairly wide area of the body may be subjected to scratching without there being any tendency to reverse the direction of the hair trend. There are certain areas of the body, however, where scratching by the manus is definitely done in a manner to cause hair reversal. One such area, which I have termed the *main area of manus reversal*, is of particular interest.

This area, like the main area of pedal reversal, is subject to some variation in its actual position, since its site naturally depends upon the relative proportions of the body and the fore limb. In *Phascolarctus* it is extensive, and it starts low down upon the lumbo-sacral region as two bilateral whorls situated close together upon either side of the middle line. From these whorls the hair streams forwards upon the dorsal surface in a direction completely reversed from the normal. The reversed field terminates in front at a convergent hair line, situated in the lower costal region, which extends farthest forward in the mid line and passes down the flanks with a caudad trend to reach the ventral surface in the flexure of the groin.

The stream lines from the lumbo-sacral whorls pass downwards and forwards at the anterior limit of the area, and downwards and backwards, merging with the normal stream at the hinder extremity. This is the area which is

scratched in a forward direction by the strong claws of the Koala, and it represents the normal reach of the manus in scratching the coat in a reversed direction.

In *Wallabia* (*Macropus*) *greyi* the main area of manus reversal is situated nearer to the anterior end of the body, since the short arms have a more limited reach in performing the action of reversed scratching. (See Figures 22 and 23.)

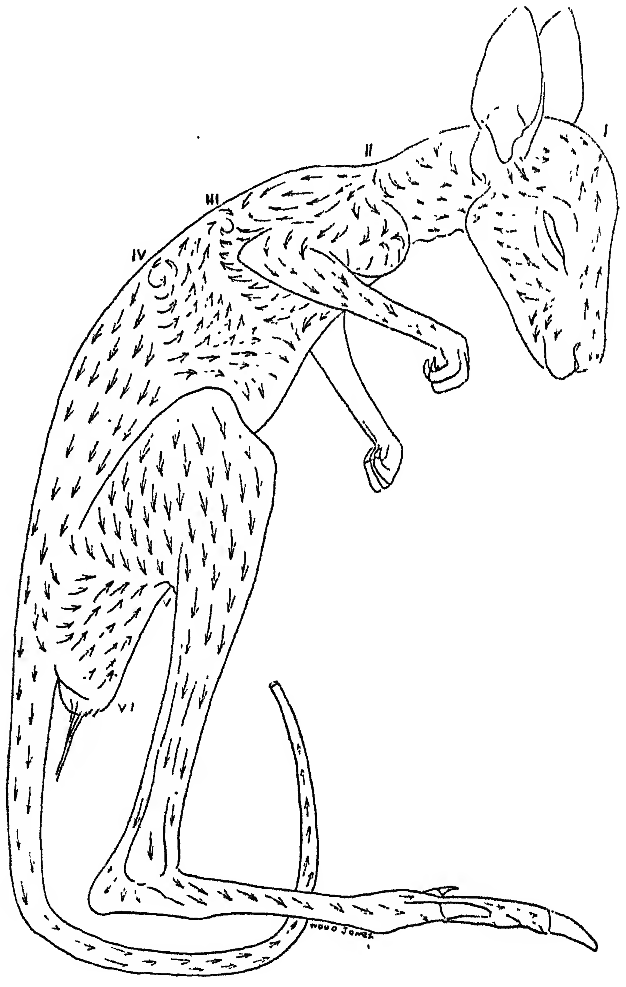

Figure 22.—Pouch young of the Toolache (*Wallabia greyi*), showing pes reversal, I.-II., manus reversal, III.-IV., and ventral manus reversal, V.-VI.

In this animal the start of the area is again in bilateral whorls, which, instead of being situated over the lumbo-sacral region, are shifted forward to the lower costal region. From

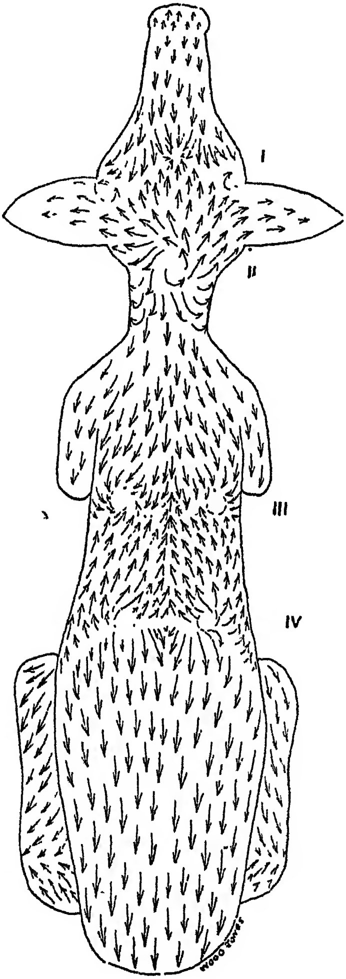

Figure 23.—Dorsal view of young Toolache (*Wallabia greyi*), showing pes reversal, I.-II., and manus reversal, III.-IV.

these whorls the reversed area runs forward and terminates at a convergent and whorled line over the scapular region. It is interesting to note, that, whereas the main area of pedal

reversal starts at a single mid line whorl, the main area of manus reversal starts, in these types at least, in bilateral whorls.

In *Wallabia greyi* and in the Kangaroos, there is another area of manus reversal upon the ventral surface of the body, extending over the perineal and lower abdominal region. This area I have termed the *ventral manus reversal area*. Now the designation of these reversed fields as areas of manus and pes scratching is no mere matter of abstract nomenclature; for this manus and pes scratching in a direction reversed from the normal hair trend is the hall-mark of the animals under consideration.

The coincidence of reversed scratching by manus and pes with the areas of hair reversal is a thing which may be witnessed constantly during observation of the living animal. There is still another reversal present in many Marsupials (as well as in many Monodelphians), which I have termed elsewhere the *rhinal reversal area*.

This area involves the very fine hairs situated just above and behind the naked rhinarium. From watching *Trichosurus*, I have come to the conclusion that this reversal is created by the forward licking of the area by the tongue. Many animals sweep the tongue around their mouths—lick their chaps—at the completion of a meal; and, in this licking, the area immediately behind the rhinarium tends to be reversed. This action is well seen in the domestic cat, in which animal the rhinal reversal is particularly well displayed. I have, therefore, come to the conclusion, from observations on living animals, that the rhinal reversal is a licking reversal. I have suggested elsewhere (24) that the well-known groin reversal of horses is in reality caused by the upward licking at that part of the body which a horse can reach with its tongue. To this point it is to be hoped that those in constant association with horses would direct attention.

If these hair tracts of mammals have every appearance of being caused by the method of the coat toilet, it may well be asked if the hair of our scalps, subjected for so long to the attentions of our artificial toilet implements, shows the development of hair tracts that might be correlated with the use of these implements. In 1901 Dr. Walter Kidd wrote

(24) *Journal of Anatomy*, Vol. LIX., Part I., p. 76.

an admirable paper on the hair tracts of man [25], and in it he pointed out the high probability that the human scalp hair pattern was "due to the inherited effect through "numerous generations of the method adopted in dressing the "hair." Although Professor Bolk (*op. cit.*) has since opposed those views he has substituted no sufficient alternative factor. In a later paper [26] I have pointed out further evidence in favour of Dr. Kidd's hypothesis, and likened the human scalp reversals to those noted in the *Phalangeridæ*. In that paper the question is summarised as follows:—"In the case "of *Pseudochirus*, the area is a pes reversal, for it is made "by the use of the syndactylous toilet digits of the pes. Of "that I think there is no doubt whatever. In the case of man, "I regard it, with Kidd, as a manus reversal, being made by "the artificial toilet appliances used in the hands. Let "anyone scratch his head in idleness and see if the fingers "do not naturally encounter the whorl, and then traverse the "stream lines forwards to the forehead, sideways to the ears, "and backwards to the nape. *Pseudochirus*, with its pedal "hair comb, carries the reversal further back than man does; "but for the rest the cause and effect are similar." For myself, I believe that the casual formation of hair tracts by brushing and scratching may be extended in the human body beyond the scalp area. Indeed, just as I would recommend anyone desirous of understanding mammalian hair tracts to watch the animals at their toilet, so would I recommend the student of human anatomy to watch a man brush his hair, scratch his body, and brush his clothes.

Now, though I think it is perfectly fair to state that no one who watched a living Marsupial and compared its actions with a chart of its hair trend could fail to see that the habitual actions of the animal coincided, in a remarkable manner, with the distribution of its hair reversals, it must be remembered that in assigning habitual actions as the *causation* of hair trends, a far-reaching implication is involved.

It is this implication—that an oft-repeated external action produces hair reversals—that has probably led to the general non-acceptance of the conclusions of Thompson and of Kidd. And yet I can see no escape from accepting these conclusions. It is inconceivable to me that internal factors, such as growth and stretching of the skin, could determine

(25) *Proceedings of Anatomical Society*, 1901, p. xxx.

(26) *Journal of Anatomy*, Vol. LIX., p. 80.

the reversals in the embryo, and that then the adult animals should scratch or perform movements which would coincide with these reversals.

I am quite convinced, from my experience of observing living Marsupials, that it is the habitual actions of the animal that determine the causation of those hair trends that I have described. But here we are faced with a difficulty. An apparently trivial, habitual, action of the animal determines the disposition of its hair tracts; but these hair tracts are already fully determined in the embryo as soon as ever its hair appears, and long before it has performed any of its habitual actions. It would be idle for anyone to deny that the alteration of the hair trend by scratching was anything other than a trivial acquired character, begot during the lifetime of the adult; a character stamped on the animal from the repeated performance of a trivial action. And yet we see that, in the embryo, the effects of this habit are visible in the hair tracts as soon as ever these are determined in the developing hair, and long before the young animal has started to rehearse any of its inherited habits.

It is difficult to understand how these hair tracts of the Marsupials can be construed as anything other than as instances of the inheritance of an acquired character.

Almost certainly it is the Lamarckian import of Kidd's work that has caused it to be adversely criticised, and which has led Bolk back again into the vagueness of expressions concerning the internal factor of the growth of the skin.

The ultimate implication of any explanation of a natural phenomenon must, of course, be borne in mind; but, if the explanation seems to be the true one, then we should consider well before we reject it, even though its acceptance imperils certain cherished beliefs.

It may be that to-day we are over given to estimating the value of facts by measuring them as items that do, or do not, fulfil the demands of existing theories. The day of true science will not dawn until we measure our existing theories by the metre of known facts. When it is appreciated that no single, well-established fact can be rightly disregarded, but that a dozen theories may be relegated to the scrap heap any day, without loss to science—then will science reign.

NOTES ON SOME TASMANIAN MESOZOIC PLANTS.

Part II.

By

A. B. WALKOM, D.Sc.,

Secretary, Linnean Society of New South Wales.

Plate IX.

(Read 13th July, 1925.)

This paper completes the examination, undertaken last year, of a series of fossil plants from the Mesozoic Rocks of Tasmania. In addition to the collections of the Tasmanian Museum and Geological Survey, I have also had the opportunity of examining a small collection from Mt. Nicholas, presented by Mr. Alex. Montgomery to the Geological Survey of New South Wales. For this latter opportunity I have to thank Mr. W. S. Dun, who very kindly gave me his notes on the specimens, and also furnished me with the photograph of the specimen of *Pecopteris* figured here.

I take this further opportunity of reiterating my admiration of the work the late R. M. Johnston did on these fossil floras, thirty to forty years ago; and also of expressing again my appreciation of the kindness of Messrs. Clive Lord and P. B. Nye in giving me the opportunity of examining the collections and in offering every facility to assist me in the work.

The following list of thirty-three species indicates the extent to which the Tasmanian Mesozoic flora is now known, and compares favourably, as regards number of known species, with any of the floras of Mesozoic age in Australia:—

Equisetales:

Neocalamites Carrerei, Zeiller.
Phyllotheca australis, Brongn.

Filicales:

Cladophlebis australis (Morris).
„ *tasmanica* (Johnston).
„ *Johnstoni*, Walkom.
? *Phlebopteris alethopteroides*, Eth. Jr.

Thinnfeldia Feistmanteli, Johnston.
„ *odontopteroides* (Morris).
„ *lancifolia* (Morris).
„ *acuta*, Walkom.
„ cf. *talbragarensis*, Walkom.
Johnstonia coriacea (Johnston).
„ *dentata*, Walkom.
„ *trilobita* (Johnston).
Linguifolium diemenense, Walkom.
„ *Lillieanum*, Arber.
Sphenopteris Morrisiana, Johnston.
Pecopteris (cf. *Hillæ*, Walkom).
Tæniopteris Morrisiana, Johnston.
„ *Carruthersi*, Tenison-Woods.
Sagenopteris moribunda, Johnston.
Chiropteris tasmanica, Walkom.

Cycadophyta:
Pterophyllum Strahani, Johnston.
„ *risdonensis*, Johnston.
„ (*Anomozamites*) *inconstans* (Braun).
Pseudoctenis sp.
Sphenozamites Feistmantelii, Johnston.

Ginkgoales:
Ginkgoites digitata (Brongn.).
„ *salisburioides* (Johnston).
Baiera tenuifolia, Johnston.
? *Baiera bidens*, Tenison-Woods.
? *Czekanowskia* sp.
Phœnicopsis elongatus.

Neocalamites Carrerei has been recorded from rocks of Rhætic age in Tonkin and South Africa, and from the Ipswich Series, of Upper Triassic age, in Queensland.

Phyllotheca australis is more typically a Permian species, occurring in association with the Glossopteris flora. It is present in the Triassic Narrabeen Stage of the Hawkesbury Series in New South Wales, and has been recorded, with some doubt, from the Ipswich Series of Queensland.

Cladophlebis australis is of very widespread occurrence in Australia and New Zealand, as well as other parts of the world, in rocks of Triassic, Jurassic, and Cretaceous ages, and affords no indication of the exact horizon of the rocks in which it occurs.

Cladophlebis tasmanica and *C. Johnstoni* are so far only known from Tasmania.

Phlebopteris alethopteroides, described from rocks of the Walloon Series (Jurassic) in Queensland, was compared with the European *Phlebopteris polypodioides*, which is now placed in the genus *Laccopteris*. This latter genus is widely spread in Rhætic, Jurassic, and Lower Cretaceous floras, but up to the present the Australian species has only been found in Jurassic rocks.

Thinnfeldia. The distribution of this genus in Australia is of interest. It has been pointed out that in Queensland there are no records of *Thinnfeldia* from the Walloon Series, all the known occurrences being in the Ipswich Series or its equivalents. In New South Wales, however, although *Thinnfeldia* is abundant in the Triassic floras, it is also present in the Talbragar beds in association with *Tæniopteris spatulata*; these Talbragar beds are indicated to be of Jurassic age, both by their stratigraphical relations and by their fossil flora. In New Zealand, *T. Feistmanteli* occurs in ? Rhætic and also in Middle Jurassic rocks; *T. lancifolia* and *T. odontopteroides* only in rocks of Rhætic age. In Tasmania there are five species of *Thinnfeldia*, four of which (*Feistmanteli, odontopteroides, lancifolia,* and *acuta*) occur in the Ipswich Series of Queensland, or its equivalents (Rhætic, or a little older), and the fifth (cf. *talbragarensis*) is a species intermediate between *Feistmanteli* and *lancifolia*, which was described from the Jurassic Talbragar Beds.

The genus *Johnstonia* is not known outside of Tasmania, and the three species included in it cannot yet be used for purposes of correlation.

Linguifolium Lillieanum is a species described by Arber from rocks of Rhætic and ? Lower Jurassic age in New Zealand, but has not hitherto been recorded from Australia. *L. diemenense* is only known from Tasmania.

Sphenopteris Morrisiana is also a species known only from Tasmania.

The specimens compared with *Pecopteris Hillæ* would, if the comparison were certain, be of some value in correlating the Tasmanian strata with those of the mainland. Both sterile and fertile fronds of *P. Hillæ* have been described from the Esk Series (equivalents of the Ipswich Series) in Queensland, of Upper Triassic age.

Tæniopteris Morrisiana is only known from Tasmania; *T. Carruthersi* (= *T. tasmanica*, Johnston) occurs in the Ipswich and Esk Series in Queensland.

Species of *Sagenopteris* are not of common occurrence in Australia, and, so far, all the specimens have been referred to one species, and have been obtained from Jurassic rocks. The species *S. moribunda* from Tasmania may possibly be synonymous with *S. rhoifolia* of the mainland.

Chiropteris tasmanica appears to differ from *C. lacerata*, the only other species known from Australia or New Zealand, which occurs in the Rhætic Beds at Mount Potts, New Zealand.

Pterophyllum Strahani and *P. risdonensis* are only known from Tasmania. *P.* (*Anomozamites*) *inconstans* is referred to a species which occurs widely in rocks of Rhætic age.

Sphenozamites Feistmantelii is only known from Tasmania.

Ginkgoites digitata is a very widespread Jurassic species, and specimens referred to it have been obtained from the Ipswich and Esk Series in Queensland. A similar form is *G. moltenensis* from the Rhætic of South Africa.

Ginkgoites salisburioides cannot at present be correlated with any species occurring in other localities. The small rosette-shaped structures found in association with *Baiera tenuifolia* are similar to those described from the Ipswich Series in Queensland, and also from the Stormberg Beds in South Africa, as *Stachyopitys annularioides*.

Baiera bidens, a common Jurassic type, occurs in the Ipswich Series in Queensland, and *B. australis*, a similar form, is found in the Jurassic of Victoria.

The type of leaf described as *Phœnicopsis elongatus* is common in the Esk Series of Queensland, and also occurs in the Stormberg Beds of South Africa, both of Rhætic age. Similar leaves have been described from Rhætic rocks in South America.

Of this list of thirty-three species there are seventeen which are known definitely to occur in other Mesozoic floras.

The following table indicates which of these seventeen species are also found in other Australian Mesozoic floras:—

	Narrabeen Beds, N.S.W. (L. Trias.)	Ipswich and Esk Series, Q'land (Rhætic).	Rhætic of New Zealand.	Walloon Series, Q'land (Jurassic).	Talbragar Series, N.S.W (Jurassic).	Jurassic of New Zealand.	Jurassic of Victoria.
Neocalamites Carrerei		x					
Phyllotheca australis	x	x					
Cladophlebis australis		x	x	x	x	x	x
Phlebopteris alethopteroides				x			
Thinnfeldia Feistmanteli	x	x	?		x	?	
„ *odontopteroides*		x	x				
„ *lancifolia*	x	x	x				
„ *acuta*		x					
„ *talbragarensis*					x		
Linguifolium Lillieanum			x			x	
Pecopteris Hillae		x					
Taeniopteris Carruthersi		x					
Pterophyllum inconstans							
Ginkgoites digitata		x					
Baiera tenuifolia		x					
„ *bidens*		x					
Phoenicopsis elongatus		x					
	3	13	5	2	3	3	1

This shows thirteen of the seventeen species to be common to the Tasmanian flora, and that of the Ipswich and Esk Series of Queensland, and leaves no doubt that there is a much closer relation between these two floras as at present known than between the Tasmanian and any other flora in Australia and New Zealand.

It is notable that the only species common to this Tasmanian flora and the Victorian Jurassic flora is *Cladophlebis australis*, a species which is present in almost every Mesozoic flora known.

Perusal of the foregoing notes on the distribution of the species occurring in the Tasmanian Mesozoic flora gives strong support for the suggestion that the whole of the collections examined by me have been obtained from rocks of Upper

Triassic (Rhætic) age, and that these may be correlated as regards their age with the Ipswich Series (and its equivalents, the Esk Series, and probably also the Lower portion of the Tiaro Series) of Queensland, and the Rhætic beds occurring at Mount Potts and the Clent Hills (Canterbury).

As stated in the first part of this paper, very many of the specimens examined have been without locality labels, and it now remains for someone with a knowledge of the field geology of the rocks from which these fossils were collected to identify as many of the specimens as possible lithologically. I feel sure that correct localities could be determined in this way for more than 90 per cent. of the specimens.

Until this has been accomplished, little further can be done in correlating the fossil collections from different districts with one another, and with those obtained from the various Mesozoic strata of Australia and New Zealand.

REVISION OF THE DETERMINATIONS OF R. M. JOHNSTON AND O. FEISTMANTEL.

In view of the long period which has elapsed since R. M. Johnston and O. Feistmantel described collections of Tasmanian plants, and of the many changes in nomenclature since those days, it is considered that the following revision of the names applied to their figured specimens will be of considerable value and interest to students of Tasmanian fossil floras. Only the figured specimens have been dealt with, as one can feel reasonably certain of identification in these cases, whereas there would be too much uncertainty attached to a similar treatment of those species which were described but not figured.

R. M. Johnston. (Pap. Prop. Roy. Soc. Tas., 1886.)		Revised Nomenclature.
Pl. 1.		
1-1A *Pterophyllum Strahani*	=	*Pterophyllum Strahani.*
2 *Salisburia hobartensis*	=	? *Baiera bidens.*
4-4A *Sagenopteris salisburioides*	=	*Ginkgoites salisburioides.*
5-5A *Glossopteris moribunda*	=	*Sagenopteris moribunda.*
Pl. 2.		
1 *Alethopteris serratifolia*	=	*Cladophlebis australis.*
2 *Neuropteris tasmaniensis*	=	? *Thinnfeldia lancifolia.*
Pl. 3.		
1 *Cyclopteris australis*	=	*Ginkgoites digitata.*
2 *Baiera tenuifolia*	=	*Baiera tenuifolia.*
3 *Ginkgophyllum australis*	=	?
4 *Neuropteris antipoda*	=	? *Cladophlebis australis.*
5 *Odontopteris crispata*	=	*Pterophyllum (Anomozamites) inconstans.*
6 *Pterophyllum (?) dubia*	=	? *Taeniopteris* sp.

Pl. 4.

1-2	*Sphenozamites Feistmantelli*	= *Sphenozamites Feistmantelii.*
3	*Taeniopteris tasmanica*	= ? *Taeniopteris Carruthersi.*
4	*Trichomanides Ettingshauseni*	= ?
5	*Thinnfeldia media*	= ? *Thinnfeldia lancifolia.*
6	*Thinnfeldia trilobita*	= *Johnstonia trilobita.*

R. M. Johnston.
Geology of Tasmania (1888).

Pl. 25.

1	*Pecopteris (Thinnfeldia) odontopteroides*	= *T. lancifolia.*
2	,, ,, ,,	= *T. lancifolia.*
3	*Thinnfeldia* sp.	= *T. Feistmanteli.*
4	*Pecopteris (Thinnfeldia) odontopteroides*	= *T. lancifolia.*
5-6	*Alethopteris australis*	= *Cladophlebis australis.*
7	*Thinnfeldia obtusifolia*	= *T. odontopteroides.*
8	*Alethopteris australis*	= *Cladophlebis australis.*
9	*Thinnfeldia obtusifolia*	= *T. Feistmanteli.*
10	*Danaea Morrisiana*	= ?
11	Fruit of a conifer	= ?
12	Seed	= ?
13	*Pecopteris caudata*	= ?
14	*Thinnfeldia obtusifolia*	= *T. odontopteroides.*

Pl. 26.

1	*Pecopteris caudata*	= ? *Linguifolium diemenense.*
2	,, ,,	= ? *Johnstonia coriacea.*
3	Unnamed	= ?
4-5	*Thinnfeldia superba*	= *T. lancifolia.*
6	*Pecopteris caudata*	= ? *Thinnfeldia* sp.
7	*Thinnfeldia obtusifolia*	= ? *T. odontopteroides.*
8	*Pecopteris caudata*	= ? *Johnstonia coriacea.*
9	*Rhacophyllum coriaceum*	= *Johnstonia coriacea.*
10-11	? *Phyllotheca*	= ? *Baiera tenuifolia.*
12	*Thinnfeldia trilobita*	= *Johnstonia trilobita.*
13-14	? *Phyllotheca*	= ? *Baiera tenuifolia.*
15	*Thinnfeldia obtusifolia*	= ? *T. odontopteroides.*
16	Seed	= ?
17	*Thinnfeldia obtusifolia*	= ?
18	? *Phyllotheca*	= ? *Baiera tenuifolia.*
19	*Cyclopteris australis* *	= ?
19a	*Baiera tenuifolia*	= ?
20	*Pecopteris caudata*	= ? *T. odontopteroides.*
21	*Thinnfeldia obtusifolia*	= *Thinnfeldia* sp.
22	cf. *Glossopteris Browniana*	= ? *Sagenopteris moribunda.*

In his "Geology of Tasmania," R. M. Johnston repeated the four plates from his paper in the Proceedings of the Royal Society of Tasmania for 1886 as follows:—Plates 1, 2, 3, and 4 = Plates 28, 23, 27, and 24 respectively of the Geology of Tasmania.

R. M. Johnston. (Pap. Proc. Roy. Soc. Tas., 1893.)	Revised Nomenclature.
Pl. 2., figs. 1-5.	
Pecopteris odontopteroides	= *Thinnfeldia lancifolia*.
(Pap. Proc. Roy. Soc. Tas., 1894-5.)	
Fig.	
1 *Neuropteris tasmaniensis*	= ? *Thinnfeldia lancifolia*.
2 *Thinnfeldia Feistmantelli*	= *T. Feistmanteli*.
3 *Pecopteris Buftoni*	= ? may be *T. lancifolia*.
4 *Pecopteris caudata*	= ?
5-7 *Strzeleckia gangamopteroides*	= ? *Linguifolium diemenense*
8 „ *tenuifolia*	= ? *Johnstonia coriacea*.
9 *Cardiopteris tasmanica*	= ?
10-13 *Sphenopteris tasmanica*	= *Cladophlebis tasmanica*.
14-15 „ *Morrisiana*	= *S. Morrisiana*.
16 *Thinnfeldia polymorpha*	= ? *T. Feistmanteli*.
17 *Gleichenia dubia*	= ?
18 *Thinnfeldia Buftoni*	= ? *T. lancifolia*.

O. Feistmantel. Uhlonosne Utvary v. Tasmanii, 1890. Prague.	Revised Nomenclature.
Pl. 7.	
3-5 *Thinnfeldia odontopteroides*	= *T. odontopteroides*.
6 *Alethopteris australis*	= *Cladophlebis australis*.
Pl. 8.	
*1 *Sphenopteris elongata*	= ? coniferous branch.
*2-4 *Sphenopteris elongata*	= ? *Baiera tenuifolia*.
*5 *Thinnfeldia odontopteroides*	= *T. odontopteroides*.
6-10 „ „	= „
*11 ? (*P. caudata*, R.M.J.)	= ?
*12 *Thinnfeldia trilobita*	= *Johnstonia trilobita*.
*13 *Thinnfeldia saligna*	= ? *Linguifolium diemenense*.
*14 *Taeniopteris Carruthersi*	= *Taeniopteris Carruthersi*.
15 *Alethopteris australis*	= *Cladophlebis australis*.
*16-17 *Glossopteris moribunda*	= *Sagenopteris moribunda*.
18-18a *Sagenopteris tasmanica*.	= ?
Pl. 9.	
*1-1a *Sagenopteris salisburioides*	= *Ginkgoites salisburioides*.
*2 *Nilssonia polymorpha*	= ? *Taeniopteris* sp.
*3 *Anomozamites inconstans*	= *Pterophyllum inconstans*.
4 *Podozamites elongatus*	= *Phoenicopsis elongatus*.
*5-6 *Sphenozamites Feistmantelii*	= *Sphenozamites Feistmantelii*.
7 *Otozamites Mandeslohi*	= †*Otozamites Mandeslohi*.
*8 Fragment of leaf	= ?
*9 *Gingko australis*	= *Ginkgoites digitata*.
Pl. 10.	
*1-2 *Anomozamites strahani*	= *Pterophyllum Strahani*.
*4-5 *Trichopitys Johnstoni*	= *Baiera tenuifolia*.
*6 *Gingko Hobartensis*	= ? *Baiera bidens*.

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* Figures marked with an asterisk are exact or slightly modified reproductions of some of R. M. Johnston's figures.

† Although I have examined a large number of specimens from Tasmania, I have seen no trace of any species similar to this.

DESCRIPTION OF AND NOTES ON SOME OF THE SPECIES.

Thinnfeldia acuta, Walkom.

Qland. Geol. Survey, Pub. 257, 1917, p. 23, Pl. 3, fig. 4.

A single specimen of portion of a *Thinnfeldia* frond may be referred to this species. It has pinnules about 3.5 cm. long and 0.7 to 0.8 cm. wide at the widest part, and which taper gradually to an acute tip. The species was described from the Ipswich Series in Queensland.

Thinnfeldia sp. (cf. *T. talbragarensis*, Walkom).

A specimen similar to that figured by Johnston as *T. polymorpha* (Pap. Proc. Roy. Soc. Tas., 1895 (1896), p. 62, fig. 16) may be compared with *T. talbragarensis*, a species occupying a position intermediate between *T. lancifolia* and *T. Feistmanteli*, described from Talbragar, N.S.W. (Mem. Geol. Surv. N.S.W., Pal. No. 12, p. 9.)

Pecopteris sp. (? *P. Hillæ*, Walkom). (Plate IX., fig. 1.)

The specimen figured is one from Mount Nicholas, which shows little detail other than the form of the frond and a median vein in each ultimate segment. The general form and the size of the pinnæ and pinnules suggest a comparison with the sterile fronds of *Pecopteris* (*Asterotheca*) *Hillæ* described from Rhætic rocks in the Esk District of Queensland (see Mem. Q'land. Mus., viii., pt. 1, 1924, p. 82). A good specimen from the collection of the Geological Survey of New South Wales is figured on Plate IX., since no similar species has previously been figured from Tasmania.

Linguifolium Lillieanum, Arber.

Geol. Surv. N.Z., Pal. Bull. No. 6, 1917, p. 38.

A number of leaves in a small collection of plants from Mount Nicholas agree very closely with this species, described originally by Arber from New Zealand. Arber's description is:—"Leaves spathulate, up to 9 cm. or more in length, and "1.7-3 cm. across at their greatest width. Margins entire, "apex rounded, leaf gradually tapering to an elongate base; "midrib well marked, persisting to the apex. Lateral veins "arising at an acute angle to the midrib, arching upwards, "and then bending to the margin, once or twice forked, "about 1 mm. apart."

Associated with these larger leaves are numerous smaller ones, which only appear to differ in size, and for the present may be regarded as belonging to the same species. These

small examples are up to 6 cm. long and 0.5 cm. wide (though usually only 0.3 to 0.4 cm. wide), with a prominent midrib and secondary veins making an angle of 25deg.-30deg. with the midrib. The secondary veins usually branch once, and at the margin are about 1 mm. apart. I have only observed them associated with the larger ones.

Sagenopteris moribunda (R. M. Johnston).

Glossopteris moribunda, R. M. Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), p. 169, Pl. I., fig. 5; Feistmantel, Uhlonosne Utvary v. Tasmanii, 1890, p. 99, Pl. 8, f. 16 and 17.

The specimens referred to *Glossopteris moribunda* by Johnston were incomplete leaves, in which the anastomosing venation was the factor relied on for the reference to *Glossopteris*. The leaves would probably be more correctly placed in *Sagenopteris*, a Mesozoic genus with a similar type of venation. The network formed by the veins is somewhat more open than in the examples of *Sagenopteris* I have seen from Queensland, and probably the Tasmanian form is a different species. Feistmantel (1890, p. 99) suggested a reference to *Sagenopteris*, and for the present the best course would appear to be to keep the specific name proposed by Johnston, but to transfer it to the genus *Sagenopteris*.

Chiropteris tasmanica, n.sp. (Plate IX., fig. 2.)

Leaf fan-shaped, outer margin apparently lobed. Veins radiating from base, branching dichotomously, about 1 mm. apart; adjacent veins joining occasionally.

This single specimen could easily be taken, at first glance, for such a species as *Ginkgoites antarctica*, but closer examination shows that the veins occasionally anastomose, and there is some indication that the outer margin may be lobed, after the manner of some examples of *G. digitata*. The specimen is 3.5 cm. from base to outer margin, and about 3 cm. wide at its widest portion. It does not agree with Johnston's *Sagenopteris salisburioides* (= *Ginkgoites salisburioides*), and for the present may be placed in *Chiropteris*, a species of which has been described by Arber from rocks of Rhætic age in New Zealand. It is very similar to the fragment figured by Seward (Ann. S.Af. Mus., iv., Pt. 1, p. 62, Pl. ix., fig. 4) as *Chiropteris cuneata* from the Stormberg Beds (Rhætic) of South Africa.

1

2

(1) *Pecopteris* sp., from shales of Mt. Nicholas.

(2) *Chiropteris tasmanica*, n.sp.

Pterophyllum (*Anomozamites*) *inconstans* (Braun.).

Odontopteris crispata, Johnston, Pap. Proc. Roy. Soc. Tas., 1886 (1887), p. 172, Pl. 3, fig. 5. *Anomozamites inconstans*, Feistmantel, Uhlonosne Utvary v. Tas., 1890, p. 108, Pl. 9, fig. 3.

The specimen placed by Johnston under *Odontopteris crispata* would seem to be more correctly placed under the division of *Pterophyllum*, in which the lamina is more or less continuous.

A somewhat similar type is *Nilssonia elegans*, Arber, described from rocks of Middle Jurassic age in New Zealand.

Sphenozamites Feistmantelii, Johnston.

The examination of additional specimens has convinced me that the best place for the specimen which, in Part I. of this paper, I referred to ? *Otozamites* is in *Sphenozamites*, where Johnston placed it in 1886. *Sphenozamites* was originally proposed as a subgenus of *Otozamites* for plants which agreed with this genus in venation and mode of attachment of the pinnæ, but in which the bases of the pinnæ were not auriculate. The additional specimens, which were amongst a later consignment forwarded me by the Geological Survey of Tasmania, show that the venation is that of *Otozamites*, *i.e.*, divergent and dichotomously branching, but that there is an absence of the characteristic lobe at the base of the pinna. It is difficult to determine the mode of attachment of the pinnæ to the rachis, but it does appear in places as if the pinna partly overlaps the rachis and is attached to the upper surface. There is in general a notable contraction towards the base of the pinna; there is also in all the specimens a number of the spine-like extensions of the lamina which are well shown in the figures. These peculiar extensions are generally traversed by a single vein, which, in cases where the extension of the lamina is itself forked, branch so that a single branch vein goes into each segment.

? *Czekanowskia* sp.

Associated with *Cladophlebis australis* at Mount Nicholas are numerous long, narrow leaves, suggestive in part of *Baiera tenuifolia*, but differing in that they are traversed by a series of delicate parallel veins or striations, and differing from that species also in an apparent absence of the branching which it commonly exhibits. Another suggestion

is that these may be leaves of an equisetaceous plant, *e.g.*, *Neocalamites Carrerei*, which has numerous long, narrow leaves at each node of the stem. The presence of a number of parallel veins, if such they be, is against this.

EXPLANATION OF PLATE IX.

1. *Pecopteris* sp. (cf. *P. Hillæ*, Walkom) from the shales of Mount Nicholas.
2. *Chiropteris tasmanica*, n.sp. Diagram to show venation.

Note.—Since this paper was written Mr. P. B. Nye, Government Geologist of Tasmania, has pointed out that the fossil plants described have practically all been obtained from the Middle or Felspathic Sandstone Series, the classification of the Mesozoic Rocks known as "Trias-Jura" in Tasmania being as follows:

Upper Sandstone Series.

Middle or Felspathic Sandstone Series (up to 600 feet).

Lower or Ross Sandstone Series (up to 800 feet).

A.B.W.

17th July, 1925.

STUDIES IN TASMANIAN MAMMALS, LIVING AND EXTINCT.

No. XIII.

THE EARED SEALS OF TASMANIA.

By

H. H. Scott, Curator of Launceston Museum,

and

Clive Lord, F.L.S., Director of Tasmanian Museum, Hobart.

(Read 10th August, 1925.)

The following notes upon the eared seals that inhabit the islands and rocks of our coasts are contributed with a view to putting upon record such data as have been accumulated from time to time, respecting these interesting members of our native fauna. It is, as we have urged elsewhere, essential that a comprehensive study of our seals should be immediately undertaken, but, pending this, it is thought advisable to collect under a common heading such notes as we have hitherto committed to Museum registers, cards, and note books.

Quite recently Professor Wood-Jones has aided the taxonomy of the question by the publication of an interesting monograph upon South Australian Eared Seals in general, and the total result of his researches is now available. The extensive synonymy of the subject is tabulated in handy form, and the animals themselves are classified under three species of the genus *Arctocephalus.*

For the seal believed to be the most common resident of our smaller islands, Professor Wood-Jones proposes the new specific name of *doriferus,* an animal found in South Australian waters also. He also states that *Arctocephalus cinereus* inhabits the Straits Islands, but he is rather doubtful if the New Zealand seal *Arctocephalus fosteri* comes into our waters, although reports claim its appearance there, and Mr. Le Souef has claimed recently the Straits seal as *A. fosteri.* It will then be manifest that upon an extreme possibility no less than three species of eared seals may at times appear in Tasmanian waters, but, according to Professor Wood Jones, a single species covers most of the facts, the other two being more or less in the nature of "accidentals."

A considerable body of popular lore at our command supports the suggestion that allowing for sex, age, and seasonable variations, a single species will not cover all the facts, and thus again we urge the need for a systematic investigation into the whole seal question.

OSTEOLOGY.

We are indebted to Professor Wood-Jones for skulls of the South Australian seal of his list—*Arctocephalus cinereus*—but of the several skulls of Tasmanian seals available to us, this skull does not appear in our collections, although as likely as not the animal does come into the Straits as the Professor suggests.

At the same time our really adult, that is aged, and super-ossified skulls, come from animals well over eight feet in length (the limit set for *A. doriferus*), and, although they agree better with that species than with *A. cinereus* of the list, they do not comply with the sagittal and nuchal crest characters, unless of course we take skulls of less than twelve years of age. Skulls of eight, nine, ten, and eleven years still show phases of crest development, and we very much doubt if any male seals of our coasts ever acquire a maximum, in this matter, at anything earlier than twelve years.

Having pooled the resources of both of our Museums upon the item of seals' skulls, we find the following facts to obtain:—

A male of our eared seal, of at least twelve years of age, shows a sagittal crest that extends forwards to the middle of the orbital processes of the frontals, a total length of 135 mm. Bifurcating into a pair of V-shaped ridges, the super-ossification extends forwards until it involves the original maxillo-frontal sutures, which are buried beneath the bony overgrowth, as are practically all the sutures of the skull. This specimen was obtained at Cooee.

A male skull of 10½ to 11 years of age obtained by the Launceston Marine Board (from our coasts) shows much sutural extinction, a true crest of 90 mm., with a remaining incipient crest of 40 mm., and the bifurcating ridges well in evidence.

A male of 9½ to 10 years of age, from North Bay, South Eastern Tasmania (Tas. Mus. No. D. 737), shows an individual age variation, inasmuch as the crest is fairly well marked for 120 mm., but the secondary bifurcations are

still unossified. In the cranial regions this skull shows much super-ossification, but the maxillo-palatine sutures are all open.

In an 8 to 9 year-old male from Scamander (animal in the flesh measured over eight feet long) the sagittal crest is only 65 mm. long, all sutures are in evidence, and the ligamentum nucha was chiefly implanted into two well-marked fossæ 25 mm. long. The cranial areas of the skull show mottled super-ossification, and the whole skull generally might —in the absence of other evidence—be regarded as a fair example of a mature skull, but any characters derived from the condition of the sagittal crest would be tentative only.

In a male of 5 years of age, believed to have come from Barren Joey, the characters of the male skull are well marked off from those of the female, but the crest is now only developed as far forward as the parieto-frontal sutures, a matter of about 35 mm. in length. The texture of the skull is compact and an area of 35 x 25 mm. on either side of the crest is syndesmosially pitted and roughened. The fossæ for the nucha are nearer the centre than obtains in the older skull, and are shallow and less extensive in other ways.

FEMALE SKULLS.

In a fully adult female skull from Bicheno, Eastern Tasmania (Tas. Mus. D. 746), in which super-ossification has obliterated all the cranial sutures, ankylosed into a solid mass the whole of the hard palate and left no fenestrated bony tissue in evidence anywhere, the nuchal and sagittal crest conditions are as follows:—A long low sagittal crest is present, some 8 mm. in height and 90 mm. long, its foremost point of extension being 18 mm. behind the line of the left orbital process and 12 mm. behind the right process. Once seen, this female crest would never be mistaken for that of a young male, even if the calvarium of the skull alone were available. It is a well-formed solid, but low crest and its highest point is in the middle. The nasals in this skull extend backwards 6 mm. beyond the maxillo-frontal and sutures, and apparently this obtains in all the Tasmanian crania at our disposal. This should be noted as it does not agree with Professor Wood-Jones's determinative character for the species *doriferus*, of which he says—"Posterior ends "of the nasals nearly reaching posterior margins of the "superior maxillæ" (*loc. cit.*). The fossæ for the implantation of the nuchæ are well marked and extend for 25 mm.

beneath the crest—they are grooves rather than pits, thus adding another age character to the skull. It is at present assumed by us that this skull is at least 8 years old, and that female skulls mature much faster than male skulls, as the animals do themselves, but in the absence of skulls from duly branded animals, our data are comparative only, the standard taken being that of Californian seals.

In a mutilated female skull from Tamar Heads, in which the sutures are all open, the squamosal and otocranial elements are movable, and although the parietals are pitted no true super-ossification has taken place, we get the appended notes upon the crest. The total outline of the future crest is well indicated, its length being 85 mm. Its strongest ossification is at the fronto-parietal sutures, which later in life would have been its highest point. Except for its lesser development, it duplicates the conditions of the maturer skull just passed in review, and is distinct from the method of development found in the young male skull, in which latter the crest slowly creeps forward with a stronger posterior elevation throughout the process.

RECAPITULATION.

It would appear, therefore, that our most common eared seal is rather larger than Professor Wood-Jones allowed for in the construction of his table of specific characters of *Arctocephalus doriferus*, that its nasal and crest osteological data do not quite agree, but these are minor matters in a way, and easy of emendation if a study of the living creatures we are so strongly urging does not show them to belong to another species. As no age standards for our eared seals founded upon branded animals exist, we have set up the best standard the circumstances permit of, and its application to the development of the males and female sagittal and nuchal crests, should be of interest in any case.

LITERATURE CITED.

1. The Eared Seals of South Australia. Rec. South Aus. Mus., Vol. 3, No. 1, June, 1925. By Frederick Wood-Jones, D.Sc., F.R.S.

2. Seals of the Challenger Expedition. By Sir William Turner, F.R.S.

3. Fur Seals of Pribolof Islands, &c. Amer. Bur. of Fisheries. June, 1915.

ON A SUPPOSED PHYLLOCARID FROM THE OLDER PALÆOZOIC OF TASMANIA.

By

F. CHAPMAN, A.L.S.

(Communicated by Sir T. W. Edgeworth David.)

Plate X.

(Read 10th August, 1925.)

DESCRIPTION.

(?) *Hurdia davidi*, sp. nov.

Carapace (right valve), obovate, with a ventral prolongation (probably somewhat distorted by pressure); with a rounded anterior and prolonged posterior extremity. Dorsal edge gently convex towards the anterior, more strongly so in the posterior region. Ventral border concave near the abdominal arch, becoming convex and distally obscurely extended in the middle region, and meeting the concave margin anteriorly. Surface of carapace wrinkled with three or more undulatory folds, crossing obliquely from the upper anterior towards the lower posterior margin. Surface marked with coarse areolation. Dorsal margin crenulate to undulose, a character probably caused by the compression of the chitinous and inflated carapace.

DIMENSIONS.

Length, circ. 5 cm.

Height of carapace, excluding the ? ventral prolongation, 18 mm.

Total length of carapace, circ. 27 mm.

OBSERVATIONS.

There is very little doubt as to the organic origin of this specimen, as the wrinkling of the margin, referred to as the dorsal line, will show.

A comparison was made with the genus *Hymenocaris*, but the general shape is too trigonal or not sufficiently oval for that generic type. The nearest genus to which we can refer this fossil, but with some reservation, is *Hurdia*, described by Dr. C. D. Walcott (1) from the Middle Cambrian of Burgess County, British Columbia. In form the present specimen approaches more nearly to *Hurdia triangulata* (*loc. cit.*). An example of *Hurdia victoria*, Walcott, in the National Museum Coll. donated by the Smithsonian Institution through the kind offices of Dr. Bassler, shows a similar wrinkling of the dorsal margin to that in the present specimen.

LOCALITY.

Emu Bay Railway Line, 4 miles S. of Hatfield Plains, Tasmania.

EXPLANATION OF PLATE.

Fig. 1. Photograph of (?) *Hurdia davidi*, sp. nov. Magnified circ. $\frac{5}{3}$.

Fig. 2. Hypothetical restoration of carapace.

Note.—Professor David reports that the railway cutting where the Phyllocarid was found is between 49.9 miles and 50¼ miles.

Dip 42° N.N.W. at 50¼ miles.

Dip 45° E. at 49.9 miles, in black shales.

At 49 miles, basalt of Hadfield Plains (edge of plains).

(1.) Smithsonian Miscellaneous Collections. Vol. LVII., No. 6, 1912, p. 186, pl. XXXII., fig. 9—*Hurdia victoria*, and pl. XXXIV., fig. 1—*Hurdia triangulata*.

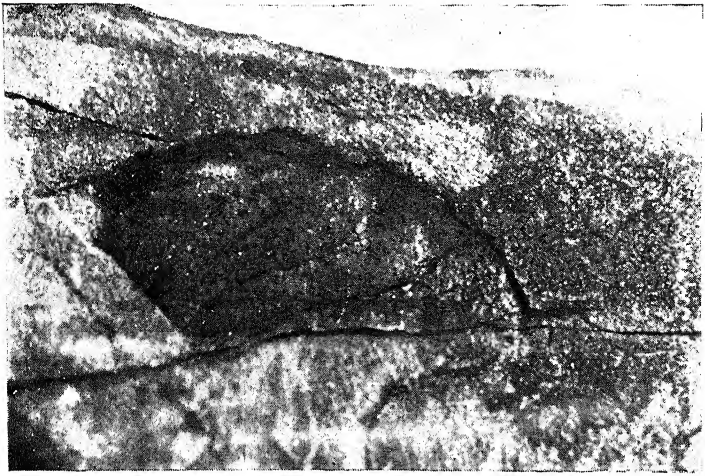


Figure 1.

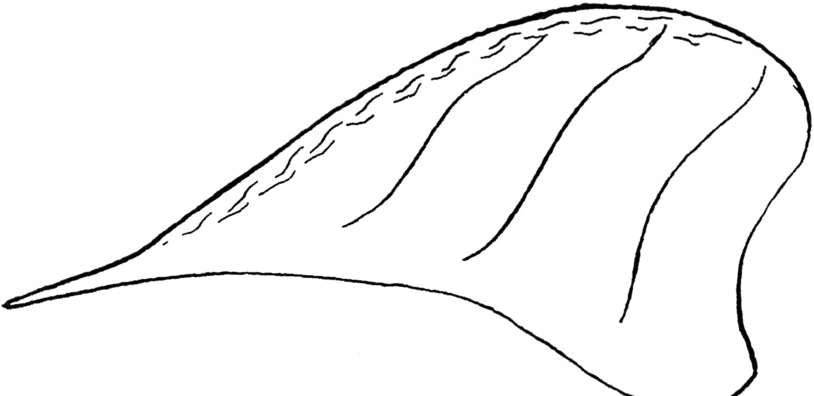


Figure 2.

Fig. 1. Photograph of (?) *Hurdia davidi*, sp. nov. Magnified circ. $\frac{5}{3}$.

Fig. 2. Hypothetical restoration of carapace.

NEW AND LITTLE-KNOWN TASMANIAN LEPIDOPTERA.

By

A. JEFFERIS TURNER, M.D., F.E.S.

(Read 12th October, 1925.)

Fam. NYMPHALIDÆ.

Subfam. SATYRINÆ.

Nesoxenica leprea, Hew.

In Mount Wellington examples the wing-markings are pale yellow, sometimes in the ♂ almost white, and the black subcostal bar at 1/3 is usually, but not always, separate from the basal dark patch; in those from Cradle Mountain and other localities of the north-west the coloration is brownish-orange, which becomes paler in worn examples, and the subcostal bar appears to be always confluent with the basal patch. These two races are at present distinguishable, but this may not be so when the intermediate mountain areas have been collected over.

Though the larvæ probably, like those of other *Satyrinæ,* feed on grasses, this butterfly appears to be attached to the Tasmanian Beech ("Myrtle") (*Fagus cunninghami*). In Cradle Valley it was flying in abundance on the edges of the myrtle forest, and never far from it, whenever the day was fine. During cold and wet weather it might be beaten from the myrtle twigs, which were abundantly covered with a black and white lichen, with which its closed wings harmonised so perfectly that it was almost impossible to detect. This protective resembance appears to point to a close correlation, which has a very ancient origin.

Oreixenica lathoniella, Westw.

I recognise three local races of this species (*latialis*, W. & L., from Mt. Kosciusko, New South Wales, and *laranda*, W. & L., I regard as distinct species). They are (1) the typical race, which is confined to Tasmania, (2) the mainland race *herceus*, and (3) what appears to be a new race, for which I propose the name *barnardi*. This last was abundant

at Moina (2,000 ft.) on the Cradle Mountain Road, and a few were taken also in the Cradle Valley (3,000ft.). It is rather smaller than the other two. The upper surface of the wings resembles *herceus* rather closely. On the underside the spots on the hindwings are a brighter white (almost silvery) than in *herceus*, and in this they resemble typical *lathoniella*, but they are considerably smaller and narrower than in the other two races, while the ground colour is darker.

Oreixenica laranda, W. & L.

But a short distance separates the localities of *laranda* and *lathoniella*, and it is highly probable that they will be found to occur in the same localities. *Laranda* is a very distinct form, and I think the burden of proof should rest with those, who would consider it only a subspecies.

Oreixenica orichora, Meyr.

The Cradle Mountain form *flynni* differs from that taken on Mt. Kosciusko (1) in the apical ocellus being always double (in the latter it is very rarely so), (2) in the brown markings being less developed in proportion to the fuscous ground colour on the upper side, (3) in the whiter colour of the subterminal line of the forewings beneath, (4) in the spots on the underside of the hindwings being smaller and whiter, while the ground colour is darker, and (5) in the forewings being differently shaped, the apex more obtusely rounded, and the termen much more bowed. I should have attached more importance to the last difference, were it not that two specimens from Mt. Hotham, Victoria, received from Mr. Geo. Lyell, while agreeing with those from Mt. Kosciusko in other respects, are intermediate in shape of forewings. The Tasmanian form can, I think, be regarded only as a well-marked local race.

Argynnina hobartia, Westw.

The mainland species *A. cyrila*, W. & L., differs (1) in the ocelli being less developed, (2) in the basal spot of the forewings being confined to the cell, (3) in the shape of the forewings, which are notably longer, more produced, and narrower towards the apex, which is more sharply rounded, (4) in the presence in the ♂ of a cubital ridge of raised scales. I have placed these differences in the order of increasing importance. The last two are amply sufficient to indicate that *cyrila* is a distinct species, although closely allied.

Fam. LARENTIADÆ.

Pœcilasthena xylocyma, Meyr.

Mount Wellington (2,500 ft.) and Russell Falls in January; two ♀ examples exactly corresponding to a ♀ from Nowra, near Jervis Bay, New South Wales. Unfortunately in the absence of the ♂ it is impossible to be certain that this is the same as Meyrick's species, which was recorded from Albany, West Australia.

Pœcilasthena ædœa, n.sp.

αἰδοῖος, modest.

♂ ♀. 24-28 mm. Head and thorax ochreous-whitish; fillet whitish; face brown. Palpi 2/3; ochreous-whitish. Antennæ ochreous-whitish; ciliations in ♂ minute. Abdomen ochreous-whitish, with two or three pairs of fuscous dorsal dots. Legs fuscous; posterior pair ochreous-whitish. Forewings triangular, costa gently arched, more strongly towards apex, apex round-pointed, termen slightly bowed, oblique; ochreous-whitish, with some minute dark-fuscous dots on veins, and numerous, fine, wavy, pale-fuscous transverse lines; median band ill-defined anteriorly, posteriorly defined by a band of three more or less fused lines, which are sometimes dark-fuscous on dorsum, outer edge from 4/5 costa to 2/3 dorsum, slightly bowed, and often marked by dark-fuscous dots or streaks on veins; a dark-fuscous discal dot in median band; two wavy subterminal lines enclosing an ochreous-whitish line; a series of elongate, interneural, dark-fuscous terminal dots; cilia ochreous-whitish. Hind-wings with termen rounded, slightly dentate, with a more prominent tooth on vein 4; as forewings, but without discal dot. Underside ochreous-whitish.

May be distinguished from the preceding by the different shape of hindwings; *scoliota*, Meyr., differs in the fuscous face and dots on thorax.

Russell Falls in January; Rosebery and Strahan in February; six specimens.

Microdes hæmobaphes, n.sp.

αἱμοβαφής, blood-stained.

♀. 23 mm. Head and thorax whitish mixed with fuscous and a few reddish scales. Palpi very long (5); whitish mixed with fuscous. Antennæ grey. Abdomen whitish, mixed with grey and reddish on dorsum. Legs fuscous; tarsi annulated with whitish; posterior pair wholly whitish.

Forewings elongate-triangular, costa rather strongly arched, apex round-pointed, termen slightly bowed, slightly oblique; whitish rather extensively, but patchily suffused with reddish, and with fuscous irroration and markings; a small basal patch defined by a strongly curved transverse line; several indistinct transverse lines precede and follow this; a broad median band, darker and more reddish-suffused, containing a minute fuscous discal dot; antemedian line from ¼ costa to 1/3 dorsum, outwardly curved, indented beneath costa and in middle, its posterior edge broadly suffused; postmedian from 2/3 costa, at first outwardly oblique, sharply angled above middle, thence wavy to dorsum about 2/3; immediately following it is a broad white line bisected by a fuscous line; some reddish suffusion in terminal area; a fine white dentate subterminal line; an interrupted fuscous terminal line; cilia whitish, barred with fuscous. Hindwings with termen strongly rounded; grey-whitish; towards termen suffused with grey; a faintly indicated subterminal whitish line; cilia grey-whitish. Underside whitish; forewings grey towards termen, with whitish subterminal line; hindwings with fuscous discal dot and postmedian line.

Lake Fenton (3,500 ft.) in January; one specimen (W. B. Barnard).

Eccymatoge iopolia, n.sp.

ἰοπολιος, purple-grey.

♂. Head purple-grey; fillet white; face fuscous. Palpi short (1), slender; fuscous. Antennæ grey, becoming white towards base; ciliations in ♂ very short (¼). Thorax purple-grey. Abdomen grey, with paired segmental dark-fuscous dots; crests and apices of segments white. Legs fuscous. Forewings triangular, costa nearly straight, slightly arched towards base and apex, apex pointed, termen bowed, oblique; whitish, densely suffused with purple-grey; lines fuscous; an undefined darker basal patch containing several obscure oblique lines; antemedian from 1/3 costa to 2/5 dorsum, crenulate, sometimes interrupted; closely followed by a fuscous discal dot; an irregularly dentate line from 2/3 costa to mid-dorsum; another irregularly dentate line, edged posteriorly with whitish, from 5/6 costa to 2/3 dorsum, the space between this and previous line filled in with dark purple-grey; a slightly dentate fuscous subterminal line, followed by a slender submarginal line; a terminal series of dark-fuscous lunules; cilia whitish, with an interrupted, grey, median line. Hindwings with termen

rounded, slightly dentate; as forewings, but without basal patch, and markings less defined. Underside grey; markings very obscure.

Cradle Mountain (3,000 ft.) in January; two specimens.

Eucymatoge liometopa, n.sp.

λειομετωπος, smooth-faced.

♂. 24-28 mm. Head fuscous; face with slight rounded prominence, only slightly rough-scaled, without frontal tuft; blackish. Palpi 1½; blackish. Antennæ fuscous; in ♂ very shortly ciliated. Thorax and abdomen fuscous mixed with blackish. Legs fuscous; posterior pair fuscous-whitish. Forewings triangular, costa slightly arched, apex pointed, termen bowed, oblique, crenulate; brown-whitish, with indistinct, wavy, fuscous, transverse lines; an ill-defined darker basal patch; median band ill-defined anteriorly, edged posteriorly by a fuscous line, partly margined by a whitish line or by whitish dots on veins, containing several obscure fuscous lines and a blackish discal dot; a narrow brownish shade immediately follows median band; a very indistinct, whitish, wavy, subterminal line; a fuscous terminal line interrupted on veins; cilia fuscous. Hindwings with apex quadrangular on vein 7, an acute tooth on vein 6, a larger acute tooth on vein 4, and three small dentations between this and tornus, termen with a deep semicircular incision between veins 4 and 6; as forewings, but without basal patch and discal dot. Underside fuscous-grey, with no defined markings.

This obscure species is readily distinguishable by the form of frons and termen of hindwings. These peculiarities do not seem to me to justify generic separation.

Russell Falls, National Park, in January; four specimens.

Horisme leucophanes.

Hydriomena leucophanes, Meyr., 1890, p. 856.

♂ ♀. 34-38 mm. Head brownish-grey. Palpi in ♂ 2½, in ♀ 3; fuscous. Antennæ grey; ciliations in ♂ minute. Thorax brownish-grey; a small posterior dark-fuscous crest. Abdomen grey. Legs fuscous; anterior pair darker. Forewings elongate-triangular, costa nearly straight except towards apex, apex acute, termen bowed, strongly oblique, crenulate, dorsum slightly arched; grey-whitish with numerous, fine, wavy, fuscous or brownish, oblique lines; a broad,

oblique fuscous or brownish streak from 1/5 costa towards, but not reaching costa at 1/3; median band not defined anteriorly, but its central area free from lines, more or less whitish, and containing a blackish discal dot; in one example a suffused blackish spot in median band below middle; posterior edge of median band more or less defined by a fine dark-fuscous line from 5/6 costa, twice waved outwards in disc, then inwardly oblique to 2/3 dorsum; lines immediately following, and sometimes those preceding, this are brownish; a short, oblique, pale, apical shade, edged beneath with dark-fuscous; a dark-fuscous terminal line; cilia grey. Hindwings broad, termen only slightly rounded, dentate; whitish, towards termen suffused with grey; several short grey lines from dorsum; a slender, fuscous, transverse line from 2/3 dorsum to beyond middle of disc; terminal line and cilia as forewings. Underside grey; markings very undefined, but a blackish discal dot on both wings.

Meyrick's description is from a single example. The species is somewhat variable.

Lake Fenton, National Park (3,500 ft.), Deloraine, Rosebery, Strahan. Also from Sale, Victoria.

Gen. EPIRRHOE.

Epirrhoë, Hb., Verz., p. 328.

Face rough-scaled, usually with projecting tuft. Tongue well-developed. Palpi porrect or subascending, moderate, rough-scaled. Antennæ in ♂ ciliated. Thorax and abdomen not crested. Thorax not hairy beneath. Posterior tibiæ, with two pairs of spurs. Forewings with areole simple. Hindwings with 5 from above middle of discocellulars.

Type *E. rivata*, Hb., from Europe. This genus is new to Australia. In my key (Trans. Roy. Soc. S.A. 1922, p. 229) it falls with *Chætolopha*, but in that genus the areole extends to 1/3 of the distance between cell and apex, while in this it does not reach ¼. The neuration of the hindwings also differs, and the genera are not in fact closely allied, the affinities of *Epirrhoë* being rather with *Euphyia*. It is also allied to the New Zealand genus *Homodotis*, Meyr. [subsequently merged by Meyrick with *Asaphodes*, but I think incorrectly], which has, however, pectinate ♂ antennæ.

Epirrhoë eustropha, n.sp.

εὐστροφος, well-banded.

♂. 28 mm. Head grey, with a few ochreous scales on crown. Palpi 2; grey, towards base whitish. Antennæ

grey; in ♂ slightly dentate, very shortly ciliated (¼). Thorax grey, mixed with whitish-ochreous. Abdomen grey, irrorated with reddish; three pairs of obscure fuscous dots on dorsum; tuft fuscous. Legs fuscous, irrorated, and tarsi annulated with ochreous-whitish. Forewings triangular, costa moderately arched, apex pointed, termen bowed, oblique; whitish sparsely irrorated with brownish and a few fuscous scales; basal patch small, purple-grey, limited by a curved, transverse, fuscous, sub-basal line; median band also purple-grey, limited by fuscous lines, and containing two very slender fuscous lines, and a minute discal dot; antemedian line from 1/3 costa to 2/5 dorsum, slightly irregular, slightly outwardly curved; postmedian from 2/3 costa to ⅘ dorsum, wavy, with slight, obtuse, median convexity; some darker suffusion towards apex and termen; a fuscous terminal line interrupted on veins; cilia grey, with a subapical whitish line. Hindwings with termen rounded; ochreous-whitish; a series of very faint, fuscous, transverse lines from dorsum, lost in disc; a fuscous terminal line; cilia whitish with an obscure grey median line. Underside ochreous-whitish, with fuscous suffusion, discal dot, and postmedian line on both wings.

Mt. Wellington (2,500 ft.), in January; one specimen.

Epirrhoë callima.

Hydriomena callima, Turn., Proc. Roy. Soc. Vic., 1903, p. 257.

♀. 26-28 mm. Head, thorax, and abdomen dark-fuscous irrorated with pale-ochreous. Palpi 2¼; pale-ochreous irrorated with dark-fuscous. Antennæ dark-fuscous. Legs dark-fuscous, irrorated, and tarsi annulated, with pale-ochreous. Forewings triangular, costa arched near base, thence nearly straight, apex pointed, termen slightly bowed, slightly oblique; dark-fuscous, with white and brown transverse lines; a small dark basal patch edged by a slender, whitish, outwardly curved, transverse, sub-basal line; this is followed by a transverse brown band, bisected by a dark-fuscous line; median band broad, dark-fuscous, but somewhat paler in centre, containing a blackish discal dot, a blackish dot on midcosta, preceded by a crenulate transverse blackish line, and followed by two such lines, the second incomplete; antemedian from 1/3 costa to 1/3 dorsum, white, slender, broader on costa, acutely indented above and below middle; postmedian from 2/3 costa to 4/5 dorsum, white, broad in upper

half, slender below, slightly indented beneath costa, with an obtuse, double, median prominence, between this and dorsum, finely crenulate, edged posteriorly by a slender blackish line, and this by a broader brown line, and this again by a blackish line; a short, slender, white streak from costa before apex; some white dots indicating a subterminal line; an interrupted blackish terminal line preceded by slight brown suffusion; cilia dark-fuscous barred with pale-ochreous. Hindwings with termen rounded; orange; suffused with fuscous at base; several short fuscous lines from dorsum; a broad dark-fuscous terminal band, interrupted in middle; cilia ochreous with small dark-fuscous bars.

Underside pale-ochreous; forewings with blackish postmedian and terminal bands, the latter with a subterminal series of whitish dots; hindwings with four fine transverse blackish lines or series of dots, and whitish subterminal dots.

Cradle Mountain (3,000 ft.), in January; three specimens. The type is from Strahan.

Euphyia orthropis, Meyr.

Mt. Wellington (2,500 ft.) and Cradle Mountain (3,000 ft.), in January; six specimens. These form a local race, which may be known as *tasmanica*, differing from the typical Mt. Kosciusko form in the forewings being fuscous, with scarcely any brownish tinge, postmedian line with usually a very slight bidentate median projection, and cilia with terminal half not or only very slightly barred with whitish.

Euphyia hilaodes, n.sp.

ἱλαώδης, of cheerful appearance.

♀. 30-34 mm. Head fuscous, irrorated with pale-ochreous and crimson. Palpi 2¼; fuscous, some irroration, and lower edge towards base pale-ochreous. Thorax fuscous, mixed with brown. Abdomen brown; apices of segments whitish; paired dark-fuscous dorsal segmental spots. Legs fuscous, irrorated, and tarsi annulated, with pale-ochreous. Forewings broadly triangular, costa gently arched, apex pointed, termen slightly bowed, slightly oblique, crenulate; pale-brown, median band darker brown; a moderate basal patch containing two darker transverse lines, limited by a slightly sinuate, fuscous, whitish-edged, transverse line; beyond this is a paler band containing a crenulate, fuscous, transverse line; median band moderate, in one example interrupted above dorsum, containing several similar fuscous lines and

a subcostal discal dot before middle; antemedian from 1/3 costa to 1/3 dorsum, whitish edged posteriorly with fuscous, slightly indented beneath costa and below middle; postmedian from 2/3 costa to 2/3 dorsum, whitish, edged anteriorly and posteriorly with fuscous, slightly waved outwards beneath costa, with a slight or moderate, double-toothed, median projection; postmedian followed by a pale-brown (sometimes whitish), and this by a fine fuscous line; a finely crenulate, slender, whitish, subterminal line; a fuscous terminal line; cilia fuscous, bases and apices paler or whitish. Hindwings with termen rounded, crenulate; whitish, suffused more or less with pale-ochreous; numerous, short, fuscous, and whitish lines from dorsum; some fuscous suffusion towards base; terminal line and cilia as forewings.

Near *E. lamprotis*, Meyr., but sufficiently distinct by the larger size, shorter palpi, crimson scales on head, indented antemedian line, projection of postmedian line less pronounced, and hindwings not orange.

Mt. Wellington (2,500 ft.), Russell Falls, and Moina (2,000 ft.), in January; Rosebery in February; six specimens, all ♀, and three of them wasted, so that I evidently came late in their season.

Euphyia heterotropa, n.sp.

ἑτεροτροπος, of different sort.

♂ ♀. 28-32 mm. Head and thorax fuscous, irrorated with whitish. Palpi 3; whitish, irrorated with fuscous; basal joint wholly whitish. Antennæ fuscous; in ♂ simple, ciliations minute. Abdomen fuscous, mixed with orange. Legs fuscous. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, slightly oblique; brownish-fuscous; an outwardy-curved, slightly dentate, whitish, subbasal, transverse line; a whitish antemedian line from 1/3 costa to 2/5 dorsum, outwardly-curved, acutely indented beneath costa and below middle; postmedian from 2/3 costa to 4/5 dorsum, whitish, at first transverse, then bent slightly inwards, then outwards to form a strong, median, obtuse projection, slightly bifid at apex, slightly incurved, and indented between this and dorsum; median band contains some obscure fuscous transverse lines and a discal dot; postmedian succeeded by a narrow pale-brownish suffusion; a fine, crenulate, whitish, subterminal line, preceded by some suffused fuscous spots; an interrupted, dark-fuscous, terminal line; cilia fuscous, bases mixed with brownish. Hind-

wings with termen rounded, wavy; dull-orange, with dark-fuscous markings; fine transverse lines at ¼, 1/3, middle, and slightly beyond middle, the last with an angular postmedian projection; subterminal and submarginal series of spots, larger and sometimes partly confluent towards apex; terminal line and cilia as forewings. Underside pale-orange, with blackish lines and discal dot on both wings; subterminal of forewings ceasing abruptly above middle, and margined posteriorly by whitish dots.

Not near any other Australian species. In two specimens the areole is simple on one side only.

Moina (2,000 ft.) and Middlesex Plains (2,500 ft.), in January; six specimens.

Gen. APROSDOCETA, nov.

ἀπροσδοκητος, unexpected.

Face rough-scaled. Tongue present. Palpi moderate, porrect, rough-scaled; terminal joint short. Antennæ in ♂ bipectinate to apex, pectinations long, one pair to each segment. Thorax and abdomen not crested. Thorax not hairy beneath. Posterior tibiæ, with two pairs of spurs. Forewings with outer wall of areole not developed, in ♂ 5 and 6 stalked from near upper angle of cell, 7 free, in ♀ 5 from slightly above middle of cell, 6 and 7 stalked from angle, in both 8, 9, 10, 11 stalked. Hindwings with discocellulars sometimes bent, 5 from junction of upper and middle thirds above bend. Type *A. chytrodes*.

I am unable to suggest any explanation for the extraordinary difference in the neuration of the two sexes. That of the ♀ is nearly the same as in *Acodia*.

Aprosdoceta orina, n.sp.

ὀρεινος, of the mountain.

♂. 42 mm. Head fuscous, irrorated with whitish-brown. Palpi 2½; fuscous; basal and apical joints whitish. Antennæ fuscous; pectinations in ♂ 10. Thorax fuscous. Abdomen brown-whitish, with slight irroration and two or three pairs of dorsal dots fuscous. Legs fuscous; posterior pair whitish, with a few fuscous scales. Forewings triangular, costa very slightly arched, apex pointed, termen longer than dorsum, bowed, strongly oblique; whitish, with fuscous irroration and markings; numerous fine transverse lines; one sub-basal and two near base represent the basal patch; antemedian from ¼ costa to 1/3 dorsum, dentate in dorsal

half; postmedian from ¾ costa to 4/5 dorsum, with an acute posterior tooth beneath costa, a median projection bearing two acute teeth, thence strongly inwardly curved, curved outwards again to dorsum; median area contains a discal dot before middle, and some fine obscure transverse lines; two fine crenulate lines between postmedian and termen; cilia whitish. Hindwings elongate, apex prominent, rounded, termen very slightly rounded, wavy; whitish, with obscure indications of short transverse lines from dorsum; cilia whitish. Underside of forewings similar, but markings suffused and indistinct, of hindwings with fuscous discal dot, antemedian, median, and postmedian lines, the last dentate.

Lake Fenton (3,500 ft.), in January; one specimen, rather worn.

Aprosdoceta chytrodes, n.sp.

χυτρωδης, earthen.

♂ ♀. 38-44 mm. Head and thorax ochreous-whitish, mixed with brown and fuscous. Palpi of ♂ 2, of ♀ 2½; fuscous; inferior surface and apex ochreous-whitish. Antennæ grey; pectinations in ♂ 12. Abdomen ochreous-whitish, in ♀ irrorated with brown, with several median dorsal fuscous spots. Legs ochreous-whitish, irrorated with fuscous; anterior pair fuscous; anterior tarsi annulated with ochreous-whitish. Forewings broadly triangular, costa gently arched, apex round-pointed, termen bowed, oblique, crenulate; whitish-brown with numerous fine, fuscous, wavy, transverse lines; a small basal patch extending twice as far on costa as on dorsum, darker, containing several fuscous lines; two fine fuscous lines precede median band; median band darker-brown, containing two anterior and three posterior suffused fuscous lines, and a fuscous discal dot before middle; antemedian line from ¼ costa to 1/3 dorsum, indented beneath costa, thence wavy; postmedian from ¾ costa to 2/3 dorsum, wavy, with slight, double, median prominence; this is followed by a whitish line; four fuscous posterior lines; subterminal whitish, crenulate, very indistinct; a broad, pale, oblique streak from apex, suffusedly margined with fuscous; an interrupted, fuscous, terminal line; cilia ochreous-whitish, apices fuscous. Hindwings with apex and tornus subrectangular, termen only slightly rounded, dentate; ochreous-whitish, with many wavy transverse lines, most developed towards dorsum; cilia as forewings. Underside of both wings ochreous-whitish, with wavy, transverse, fuscous lines, and an antemedian dark-fuscous discal dot.

Lake Fenton (3,500 ft.), in January; six specimens (W. B. Barnard).

Gen. ACODIA, Rosen.

Face with anterior cone of scales. Palpi moderate, porrect, rough-scaled. Antennæ of ♂ bipectinate almost to apex. Abdomen with a slight dorsal crest on third segment. Posterior tibiæ with two pairs of spurs. Forewings without areole, 6 and 7 approximated, connate, or stalked, 8, 9, 10, 11 stalked. Hindwings with discocellulars only slightly bent, 5 from junction of upper and middle thirds.

The absence of the areole is due to non-development of its outer wall. I am now of opinion that this genus should be maintained. Out of a series of nine examples, including both sexes, I find no deviation from the neuration described; examples with the areole developed are apparently exceptional.

Xanthorhoë pyrrhobaphes, n.sp.

πυῤῥοβαφης, suffused with red.

♂. 34 mm. Head and thorax reddish-brown. Palpi 2½; fuscous, mixed with brown; at base ochreous-whitish. Antennæ grey; ciliations in ♂ 10. Abdomen ochreous-whitish, with paired, dorsal, reddish-fuscous spots. Legs dark-fuscous; tarsi annulated with whitish; posterior pair ochreous-whitish. Forewings broadly triangular, costa slightly arched, more strongly towards apex, apex subrectangular, termen slightly bowed, slightly oblique; very pale reddish, with minute dark-fuscous dots on veins; costal edge rather deeper red; a basal patch, consisting of three or four reddish-fuscous transverse lines; median band moderately broad on costa. much narrower below middle; a blackish median discal dot; anterior edge of median band slightly outwardly curved, formed of two fine, wavy, fuscous lines, the intervening space filled in with red above middle and on dorsum; posterior edge of three such lines, filled in with red on upper third, there angled; subterminal indicated by a darker crenulate shade; a terminal series of paired fuscous dots; cilia fuscous, apices pale-reddish. Hindwings with termen rounded; grey-whitish, with several fine fuscous lines from costa; terminal dots and cilia as forewings. Underside of both wings pale-reddish, with fuscous discal dot, and interrupted postmedian line.

A second example is differently coloured, being uniformly grey, with reddish suffusion only on basal patch, median band, and to a less extent on costa and termen of forewing.

The species is therefore variable. Any possible confusion with *pauper*, Rosen., may be avoided by noticing the different form of wing margins.

Moina (2,000 ft.), in January; two specimens (W. B. Barnard).

Xanthorhoë amblychroa, n.sp.

ἀμβλυχροος, dull-coloured.

♂. 26-28 mm. Head and thorax whitish-brown, irrorated with fuscous. Palpi 2½; brown-whitish, irrorated with fuscous. Antennæ fuscous; pectinations in ♂ 6, apical 1/3 simple. Abdomen brown-whitish, irrorated with fuscous. Legs fuscous, irrorated, and tarsi annulated, with brown-whitish; posterior pair mostly brown-whitish. Forewings elongate-triangular, costa nearly straight, apex pointed, termen nearly straight, oblique; brown-whitish, with fuscous irroration and markings; a number of short, fuscous, costal strigulæ, some of which give rise to transverse lines, three suffused sub-basal lines; antemedian from 2/5 costa to 2/5 dorsum, slightly dentate, obscure; postmedian from ¾ costa to ¾ dorsum, better defined white-edged posteriorly, wavy, with an obtuse median projection, thence inwardly curved to dorsum; median area contains an obscure discal dot, and below this a small brownish mark; a very slender, wavy, white, subterminal line; an interrupted, blackish, terminal line; cilia whitish, mixed with brownish-fuscous. Hindwings with termen rounded, wavy; whitish-grey; a fuscous discal dot at 1/3; obscurely darker postmedian and subterminal transverse lines; terminal line and cilia as forewings. Underside similar, but markings on hindwings better defined.

Hobart, in December; two specimens received from Mr. R. A. Black.

Xanthorhoë bituminea, n.sp.

bitumineus, like asphalt.

♀. 30 mm. Head, thorax, and antennæ fuscous. Palpi 2½; fuscous. Abdomen fuscous; obscurely darker, paired, dorsal dots separated by median brownish dots. Legs fuscous; tarsi annulated with whitish. Forewings triangular, costa nearly straight to shortly before apex, apex acute, termen sinuate, oblique; fuscous, obscurely marked with slender, wavy, dark-fuscous, obliquely transverse lines; no defined basal patch; median band hardly darker; antemedian line hardly distinguishable; postmedian defined by a very slight, whitish posterior margin, from 5/6 costa to 4/5 dorsum; subterminal line obsolete; cilia fuscous. Hindwings with

termen only slightly rounded, crenulate; grey; with several very slender, obscure, short, transverse lines from dorsum; a darker terminal line; cilia grey, apices paler. Underside fuscous; markings on forewing ill-defined; hindwings with blackish discal dot at 1/3, and three slender, curved, transverse, dark lines at and beyond middle.

My second example is a well-marked aberration, differing as follows:—Thorax suffused with brown. Forewings with brown antemedian and postmedian bands, the latter bifurcating near costa, its outer branch running to apex.

Though the ♂ is unknown, I think this species is allied to *centroneura*, Meyr., and *epia*, Turn.

Rosebery, in February; two specimens.

Gen. ACALYPHES, nov.

ἀκαλυφης, uncovered, open.

Face rough-scaled. Tongue strong. Palpi moderate, porrect, hairy. Antennæ of ♂ thickened, simple, ciliations imperceptible. Thorax with a small posterior crest; hairy beneath. Abdomen without crests. Coxæ and femora hairy. Posterior tibiæ with two pairs of spurs. Forewings without areole, 5 from middle of cell, 6 from upper angle, 7, 8, 9, 10 stalked from before angle, 11 free. Hindwings with cell very long ($\frac{3}{4}$), 5 from middle of cell, 6 and 7 connate or short-stalked.

One of the *Dasyuris* group. The anomalous neuration can be explained by the non-development of the costal wall of the areole (disconnecting veins 10 and 11), leaving the areole open. I do not know any other instance in which this occurs.

Acalyphes philorites, n.sp.

φιλοριτης, a mountaineer.

♂ ♀. 22-24 mm. Head and thorax dark-fuscous, with some white irroration. Palpi 2; dark-fuscous, mixed with white. Antennæ dark-fuscous. Abdomen and legs fuscous, irrorated with ochreous-whitish. Forewings triangular, costa arched near base, thence nearly straight, apex rounded-rectangular, termen slightly bowed, scarcely oblique; fuscous with some whitish suffusion in disc; an ill-defined whitish sub-basal spot; a dark-fuscous, somewhat dentate, transverse line from 1/3 costa to 2/5 dorsum, suffusedly margined with white, preceded by a dark-fuscous subdorsal spot; a median transverse line, angulated outwards in middle, some-

times indistinct; a dark-fuscous line from 2/3 costa to dorsum before tornus, irregularly dentate, with a strong median posterior tooth, edged posteriorly by a broad white line, much narrowed on median prominence; dark-fuscous suffused spots follow this above middle and above tornus; an interrupted dark-fuscous terminal line; cilia fuscous, bases sometimes whitish. Hindwings with termen strongly rounded; fuscous; disc in ♀ suffused with whitish-ochreous; a white or whitish-ochreous, strongly marked, postmedian line, strongly angled posteriorly in middle, and again at tornus; cilia fuscous.

Cradle Mountain (3,000 ft.), in January; two specimens (W. B. Barnard).

Dasysternica bertha, n.sp.

Epirrhoë bertha, Swin., Trans. Ent. Soc., 1902, p. 648.

Dasysternica crypsiphœna, Turn., Trans. Roy. Soc. S.A., 1922, p. 257.

♂ ♀. 25-29 mm. Head, thorax, abdomen, and palpi dark-fuscous, with some whitish irroration; palpi 3, clothed with long rough hairs. Antennæ dark-fuscous; in ♂ slightly serrate and shortly ciliated (2/3). Legs dark-fuscous, irrorated, and tarsi annulated with whitish. Forewings triangular, costa very slightly arched, apex pointed, termen bowed, oblique; whitish, densely irrorated with fuscous, sometimes with scattered patches of brownish, and marked with dark-fuscous, more or less crenulate, transverse lines, which are more distinct in ♀; three or four suffused lines before antemedian; antemedian from 1/3 costa to 2/5 dorsum, slightly outwardly curved, slightly dentate; two or three lines in median band, whose centre is paler and contains a subcostal, antemedian, blackish, discal dot; postmedian from 2/3 costa to 4/5 dorsum, dentate, with a small subcostal and a moderate, double, median projection; this is followed by a narrow whitish line, more or less suffused; dark-fuscous subterminal and terminal lines, the latter interrupted; cilia fuscous, apices barred with whitish. Hindwings with termen rounded; dark-grey; slightly darker transverse lines, edged posteriorly with whitish, about 1/3, middle, and 2/3; the last of these is followed by a distinct whitish line, which is sometimes double; terminal line and cilia as forewings. Underside of both wings fuscous-whitish, with three dark-fuscous, crenulate, transverse lines, and a dark-fuscous subterminal shade.

The brown markings on the forewings vary much, and may be altogether absent. I have therefore redescribed the species. Some difficulty may arise as to its generic position. Of 9 male examples examined 5 have the areole simple on both sides, 2 simple on one side, double on the other, 2 double on both sides; of 10 female examples 9 have it simple on both sides, one simple on one side only. That is to say, of 38 wings 31 (81.6%) are simple, 7 (18.4%) double. This form of structural variation is exceptional.

Mt. Wellington (3,500-4,000 ft.); Lake Fenton (3,500 ft.); Cradle Mountain (3,000 ft.); in January; common.

Fam. BOARMIADÆ.

Boarmia epiphlœa, n.sp.

ἐπιφλοιος, on bark.

♂ ♀. 44-50 mm. Head grey; face dark-fuscous, with two whitish-ochreous transverse lines, above middle and on lower edge. Palpi 1¼; ochreous-whitish; terminal joint fuscous. Antennæ fuscous; ciliations in ♂ 12, extreme apex simple. Thorax pale-grey, with a blackish transverse line near anterior end. Abdomen pale-grey; sometimes fuscous spots on dorsum of second and third segments. Legs grey; anterior pair fuscous. Forewings triangular, costa nearly straight, apex pointed, termen very slightly bowed, oblique, crenulate; 10 and 11 long-stalked, 10 connected with 9 (3♂, 3♀); pale-grey; costa strigulated with fuscous; a slender blackish line from base, beneath and parallel to costa, not reaching middle; two very slender fuscous lines from dorsum near base and at ¼, strongly outwardly oblique, lost in disc; a blackish line from termen beneath apex to mid-dorsum, strongly waved, sometimes thickened; terminal area beyond this is darker grey; a short, slender, blackish, oblique streak from costa before apex; a slender, whitish, finely-waved subterminal line, its posterior edge sometimes with blackish dots, which may be connected by fine streaks between veins with a blackish terminal line; cilia grey, apices paler. Hindwings with termen straight, dentate towards apex, wavy towards tornus, which is rectangular; as forewings, but lines transverse, including a single, complete, antemedian line. Underside grey, with fuscous discal dots, and postmedian line of dots, sometimes indistinct.

Readily distinguished from *B. lyciaria* by the differently shaped hindwings and absence of yellowish colouring beneath.

Moina (2,000 ft.), in January; Strahan, in February; six specimens.

Boarmia epiconia, n.sp.

ἐπικονιος, covered with dust.

♂ ♀. 36-40 mm. Head whitish; face dark-fuscous, upper and lower edge whitish. Palpi 1; ochreous-whitish, towards apex fuscous. Antennæ grey; pectinations in ♂ 3, extreme apex simple. Thorax whitish, with a few fuscous scales. Abdomen whitish; some fuscous irroration, and paired, fuscous, dorsal dots on third and fourth segments. Legs fuscous; tarsi annulated with ochreous-whitish; posterior pair ochreous-whitish. Forewings triangular, costa gently arched, apex rather sharply pointed, termen bowed, oblique; 10 and 11 long-stalked, free (1 ♂), their common stalk connected with 12 (1 ♀); whitish with moderate fuscous irroration and fuscous lines; costa finely strigulated with fuscous; an elongate dot beneath costa at 1/3, and a median discal dot fuscous; lines strongly oblique; a very slender interrupted line from dorsum near base to about middle; sometimes a similar line beyond and parallel to this; a dark-fuscous, more distinct, interrupted line from mid-dorsum, not reaching costa; this is closely followed by a suffused, somewhat dentate, fuscous line; a whitish crenulate or dentate subterminal line; a terminal series of dark-fuscous dots between veins; cilia whitish. Hindwings with termen slightly rounded, wavy; as forewings, but lines transverse and complete. Underside pale-grey, with faint discal dot and postmedian line on both wings.

Mt. Wellington (3,000 ft.), in January; two specimens (W. B. Barnard).

Boarmia proschora, n.sp.

προσχωρος, adjacent.

♂. 35 mm. Head whitish; face dark-fuscous, upper and lower edge whitish. Palpi 1; whitish, towards apex fuscous. Antennæ grey; pectinations in ♂ 2, extreme apex simple. Thorax whitish with two pairs of fuscous spots. Abdomen whitish, with slight fuscous irroration, and paired, fuscous, dorsal dots on third and fourth segments. Legs fuscous; tarsi annulated with whitish; posterior pair whitish. Forewings rather narrowly triangular, costa gently arched, apex round-pointed, termen bowed, strongly oblique, crenu-

late; 10 and 11 long-stalked, free (1 ♂); whitish with fuscous irroration, costal strigulation, and lines; antemedian line from a spot on 1/3 costa, dentate beneath costa, thence strongly oblique to near base of dorsum; a median, fuscous, discal dot; a very slender sinuate median line; postmedian from a spot on 2/3 costa, dentate beneath costa, thence strongly oblique to mid-dorsum; a faint, whitish, crenulate, subterminal line; a terminal series of fuscous dots between veins; cilia whitish, a fuscous bar beneath apex. Hindwings with termen slightly rounded, crenulate; as forewings, but lines transverse; postmedian finely dentate; subterminal edged anteriorly by a fuscous line. Underside pale-grey, with fuscous discal dots on both wings.

Very similar to the preceding, but recognisable by the shorter antennal pectinations, forewings narrower, less acute at apex, termen crenulate, lines more complete, ending on costal spots.

Zeehan in February; one specimen.

Boarmia atycta, n.sp.

ἄτυκτος, unfinished.

♀. 46 mm. Head grey-whitish; face with a few fuscous scales only. Palpi 1½; white, towards apex mixed with fuscous. Antennæ fuscous. Thorax and abdomen whitish mixed with dark-fuscous. Legs fuscous; tarsi with whitish annulations; posterior pair mostly whitish. Forewings triangular, costa nearly straight, apex subrectangular, termen bowed, slightly oblique, wavy; 10 and 11 very long-stalked, 10 connected or anastomosing with 9 (1 ♀); whitish, irrorated throughout, and costa strigulated, with dark-fuscous; markings grey, nearly obsolete; a suffused, outwardly curved, dentate, sub-basal, transverse line; a dark-fuscous discal dot before middle; a broadly suffused postmedian line from ¾ costa to 2/3 dorsum, containing some dark-fuscous streaks on veins; traces of a dentate, whitish, subterminal line; a terminal series of dark-fuscous interneural dots, somewhat prolonged inwards; cilia whitish, with some fuscous scales. Hindwings with termen rounded; crenulate; as forewings, but without sub-basal line; discal dot at 1/3; postmedian line double, but only distinct towards dorsum. Underside pale-grey, with fuscous irroration and discal dot on both wings.

A moderately large but very obscure species.

Lake Fenton (3,500 ft.), in January; one specimen (W. B. Barnard).

Syneora symphonica, n.sp.

συμφωνικος, harmonious.

♂ ♀. 32-38 mm. Head grey; fillet darker; face prominent. Palpi in ♂ 1½, in ♀ 2; whitish, towards apex mixed with grey. Antennæ grey; pectinations in ♂ 8, apical 1/5 simple. Thorax grey. Abdomen grey-whitish, with a few dark-fuscous scales. Legs fuscous; tarsi with whitish annulations; posterior pair mostly whitish. Forewings triangular, costa gently arched, apex round-pointed, termen slightly bowed, slightly oblique, slightly wavy; 10 and 11 separate, connate or short-stalked, 11 usually anastomosing or connected by a bar with 12, occasionally 11 apparently out of 12; grey-whitish, at base, terminal area, and beyond antemedian line slightly darker, with sparse dark-fuscous irroration; a moderate basal patch partly defined by a very fine dark-fuscous line; antemedian from midcosta to 2/5 dorsum, slender, fuscous, nearly straight; a fuscous, median, discal dot; second line similar, from 4/5 costa, doubly sinuate, bent strongly inwards above dorsum to end on mid-dorsum, very fine towards dorsum, somewhat thickened in middle, edged anteriorly throughout by a whitish line; a terminal series of small interneural dots; cilia grey-whitish. Hindwings with termen rounded; whitish, towards dorsum and termen irrorated with fuscous; several short fuscous transverse lines from dorsum, lost in disc; a discal dot before middle; cilia grey-whitish. Underside whitish finely strigulated with fuscous; a discal dot on both wings.

Within the limits indicated above, 10 and 11 of forewings are excessively variable, so much so that of nine specimens examined in only one was the neuration the same on both sides.

Beaconsfield, in February; Moina (2,000 ft.), in January; Rosebery, in February; nine specimens (W. B. Barnard).

Cleora nesiotis, n.sp.

νησιωτις, an islander.

♀. 40 mm. Head and thorax whitish-grey; face fuscous, lower edge whitish. [Palpi missing.] Antennæ pale-grey; in ♀ very shortly bipectinate (½), apical ¼ simple. Abdomen and legs whitish-grey, with a few fuscous scales. Forewings elongate-triangular, costa straight, apex pointed, termen bowed, oblique, crenulate; 10 and 11 separate and free; whitish-grey with a few fuscous scales; markings fuscous; a slender, incomplete, curved line from 1/6 costa to dorsum

near base; a discal dot beneath midcosta; a sinuate line, from 3/5 costa to mid-dorsum, with an acute posterior tooth above middle, angled inwards above dorsum; a line from costa before apex, at first very obliquely inwards, then bent to form an acute posterior tooth, after that it runs inwards to become closely applied and parallel to the preceding line from beneath tooth to dorsum; an indistinct, whitish, crenulate, subterminal line; an interrupted terminal line thickened between veins; cilia whitish with an interrupted, fuscous antemedian line. Hindwings with termen nearly straight, strongly dentate; as forewings, but without distinct lines, terminal line more uniform, cilia with a fuscous dot opposite each dentation. Underside more densely irrorated with fuscous; forewings with a single postmedian line; an incomplete, subterminal, fuscous band, in forewings not reaching costa, but forming a subcostal blotch, in hindwing forming a costal blotch.

Not near any Australian, but perhaps distantly related to some of the New Zealand species.

Rosebery in February; one specimen.

Lyelliana pristina, n.sp.

pristinus, primitive.

♂. 32-33 mm. Head whitish. Palpi 2; fuscous, at base and apex whitish. Antennæ grey; in ♂ with short pectinations (1½) extending to apex. Thorax whitish; apex of shoulder-flaps fuscous. Abdomen whitish. Legs fuscous; tibiæ and tarsi annulated with whitish; posterior pair mostly whitish. Forewings rather narrowly triangular, costa strongly arched from base to middle, thence straight, apex rounded-rectangular, termen slightly bowed, slightly oblique; 9 connected with 10 soon after its separation, 10 out of stalk of 7, 8, 9, 11 from cell, free; whitish suffused and irrorated with fuscous; a dark fuscous line from near base of costa not reaching middle; a suffused fuscous line from ¼ costa, at first outwardly oblique, angled inwards in middle, thence slender and inwardly oblique to 1/3 dorsum; a similar line from 3/8 costa, very oblique to beyond middle of disc, where it is angled inwards and continued as a series of dots to mid-dorsum; a line of dark fuscous dots from 2/3 costa to 2/3 dorsum, at first outwardly curved, sinuate, each dot is edged posteriorly by a whitish dot, above middle they are replaced by short longitudinal streaks between this and previous line; a dentate, whitish, subterminal line;

followed by some longitudinal, fuscous, interneural streaks; cilia grey barred with fuscous, apices whitish. Hindwings with termen rounded; pale-grey; a transverse, interrupted, fuscous postmedian line; an indistinct whitish subterminal line; cilia grey-whitish with incomplete fuscous bars. Underside grey-whitish; fuscous discal dots and postmedian dotted lines on both wings.

Cradle Mountain (3,000 ft.), in January; two specimens.

Amelora crenulata, n.sp.

crenulatus, scalloped.

♂ ♀. 30-36 mm. Head and thorax grey, sometimes brownish-tinged; face not projecting, with sparse rough hairs, which may form a slight tuft at inferior margin. Palpi in ♂ 1½, in ♀ 3; fuscous. Antennæ grey or brownish; pectinations in ♂ 6. Abdomen grey. Legs fuscous; tarsi annulated with whitish-ochreous; posterior pair grey. Forewings broadly triangular, costa moderately arched, more strongly so near base, apex rounded-rectangular, termen bowed, slightly oblique, crenulate; grey, sometimes brownish-tinged, with a few scattered blackish scales; an outwardly-curved line of blackish dots from 1/5 costa to ¼ dorsum, a blackish discal dot beneath midcosta; a subterminal line of angular blackish dots, slightly bisinuate, sometimes with whitish dots at their posterior ends, and in one example with these linked by a very fine, whitish, dentate line; cilia concolorous. Hindwings with termen slightly rounded, crenulate; pale-grey; sometimes a grey discal dot and subterminal line of dots; cilia grey. Underside similar, but markings less distinct on forewings, more distinct on hindwings.

The slight frontal tuft is easily denuded. Specimens from Russell Falls differ in being brownish-tinged, but are otherwise similar. The length of palpi is expressed in terms of breadth of eye, and this is smaller in the ♀.

Mt. Wellington (2,500 ft.), Russell Falls, Cradle Mountain (3,000 ft.); common in January. I have also an example from Mt. Kosciusko (5,000 ft.), New South Wales, in January.

Amelora suffusa, n.sp.

suffusus, blurred.

♂ ♀. 36-45 mm. Head and thorax pale-grey; face with a strong rounded projection, smooth except at lower edge, where are some rough scales, no definite tuft; upper

part of face sometimes fuscous. Palpi ♂ 2, ♀ 2½ to 3; grey-whitish with a very few fuscous scales. Antennæ pale-grey; pectinations in ♂ 5. Abdomen pale-grey. Legs grey-whitish with some fuscous irroration, more on anterior, less on posterior pair. Forewings triangular, costa arched near base, thence straight, apex rather sharply pointed, termen bowed, oblique, sinuate; grey, sometimes ochreous-tinted, with slight fuscous irroration; markings fuscous, suffused; a rather broad, outwardly-curved, slightly dentate line from ¼ costa to 1/3 dorsum; a suffused discal spot beneath mid-costa; a broad, acutely dentate, nearly straight line from 5/6 costa to 2/3 dorsum; cilia grey. Hindwings with termen gently rounded, wavy; pale-grey; cilia pale-grey. Underside pale-grey; forewings with a pale-fuscous discal spot; hindwings with a conspicuous discal spot and general sparse irroration dark-fuscous.

In one example the whole median area of forewing between the lines is suffused with fuscous.

Mt. Wellington (G. H. Hardy) and Lake Fenton (3,500 ft.), in January; eight specimens.

Amelora cyclocentra, n.sp.

κυκλοκεντρος, with central circle.

♂. 28-30 mm. Head grey-whitish; face without definite tuft. Palpi 2; grey. Antennæ grey-whitish; pectinations in ♂ 8. Thorax and abdomen grey-whitish with a few dark-fuscous scales. Legs fuscous; tarsi annulated with whitish; posterior pair mostly whitish; posterior tibiæ of ♂ dilated with internal groove and tuft. Forewings triangular, costa gently arched, apex rectangular, termen slightly bowed, slightly oblique, wavy; pale-grey, sometimes brownish-tinged, with more or less dark-fuscous irroration; a sub-basal series of three dark-fuscous dots, median dot posterior; a circular, median, fuscous discal spot, paler in centre; a postmedian series of dark fuscous dots, sometimes connected by a very fine whitish dentate line, from costa shortly before apex to 2/3 dorsum, the two submedian dots displaced outwards; a terminal series of dark-fuscous dots; cilia grey-whitish. Hindwings with termen rounded, wavy; pale-grey; a discal dot before middle and a postmedian transverse line of dots dark-grey; cilia pale-grey. Underside of forewings grey; along costa ochreous-whitish strigulated with fuscous; indistinct fuscous discal dot and postmedian line of dots; of

hindwings whitish, irrorated with fuscous; very distinct fuscous discal dot and postmedian line of dots.

Rosebery and Strahan, in February; two specimens (W. B. Barnard).

Amelora oxytona, n.sp.

ὀξύτονος, sharp.

♀. 30 mm. Head brown; face without definite tuft. Palpi 3; pale-grey, with a few darker scales. Antennæ pale-brownish, with some fuscous scales. Thorax brown. Abdomen grey, with some dark-fuscous irroration. Legs fuscous; tarsi with ochreous-whitish annulations; posterior pair paler. Forewings triangular, costa gently arched near base, thence straight, apex acute, slightly produced, termen sinuate, slightly oblique; brown, with some fuscous irroration; markings dark-fuscous; a very distinct, transverse line from 1/6 costa to 1/3 dorsum, outwardly curved with two strong posterior dentations; a suffused, indistinct, fuscous, median, discal spot; a very distinct line from 5/6 costa to ¾ dorsum, sharply dentate, bent somewhat inwards above middle; an indistinct terminal series of dots; cilia brown. Hindwings with termen rounded, wavy; grey-whitish; discal dot and a postmedian line of dots scarcely indicated; cilia grey-whitish. Underside of forewings grey, markings obsolete except indistinct dot and postmedian line; of hindwings whitish, with fuscous irroration, discal dot, and postmedian line of dots.

Rosebery in February; one specimen (W. B. Barnard).

Gen. Ecpatites, nov.

ἐκπατίτης, out of the beaten track.

Face with cone of rough hairs. Tongue well developed. Palpi long, porrect. Antennæ of ♂ bipectinate, extreme apex simple. Thorax [partly denuded, probably a triangular anterior crest will be found in more perfect examples] with a small bifid posterior crest; beneath somewhat hairy. Abdomen not crested. Femora hairy. Forewings in ♂ without fovea; 10 and 11 arising separately from cell, 11 anastomosing with 10 soon after origin, the stalk of 8, 9 anastomosing with 10, 11, all four veins arising by a common stalk from the double areole so formed, and separating in order, or 11 arising separately shortly before end of areole. Hindwings normal.

This looks like a *Chlenias*, but is distinguished by the peculiar neuration of the forewings, which superficially re-

sembles that of many *Larentiadæ* and *Oenochromidæ*, though probably an independent development.

Ecpatites callipolia, n.sp.

καλλιπολιος, beautifully grey.

♂. 40 mm. Head whitish-grey. Palpi 3; fuscous; base and upper edge whitish. Antennæ grey; pectinations in ♂ 5. Thorax whitish-grey; shoulders grey. Abdomen whitish. Legs fuscous; tarsi annulated with whitish; [posterior pair missing]. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, slightly oblique, crenulate; grey, slightly brownish-tinged; a small brownish suffusion at base; a fine fuscous line from 1/5 costa to 1/3 dorsum, strongly angled outwards beneath costa, inwards in middle, and again outwards above dorsum; a more obscure, very fine, fuscous line from 2/5 costa to mid-dorsum; a dark-fuscous median discal dot, connected by a small white suffusion with a fine whitish line from 2/3 costa to 2/3 dorsum, angled inwards above dorsum; an oblique white streak from apex, not reaching middle; preceded by four short, longitudinal, fuscous-brown streaks; a dentate, whitish, transverse line from dorsum before tornus, preceded by a suffused brown line, which becomes fuscous towards dorsum, and succeeded by a suffused fuscous spot; an interrupted, dark-fuscous, terminal line connected by several fine lines with oblique streak from apex; grey-whitish, with some obscure fuscous bars. Hindwings broad, termen rounded, irregularly waved; grey-whitish; cilia whitish. Underside whitish-grey; with obscure fuscous discal dot and postmedian line on both wings; terminal area of forewings suffused with fuscous.

Rosebery in February; one specimen (W. B. Barnard).

Gen. ARCHEPHANES, nov.

ἀρχεφανης, conspicuous.

Face smooth, not projecting, without tuft, but with a few rough scales on lower edge. Tongue well developed. Palpi moderately long, porrect. Antennæ of ♂ thickened, dentate, minutely ciliated. Thorax with an erect posterior crest; beneath moderately hairy. Femora smooth. Posterior tibiæ of ♂ not dilated. Forewings in ♂ without fovea; 10 and 11 coincident, free, from cell. Hindwings with cell long (3/5); otherwise normal.

This and the following genus are probably allied to *Drymoptila*, Meyr.

Archephanes zalosema, n.sp.

ζαλοσημος, storm-marked.

♂ ♀. 34-38 mm. Head white; fillet black. Palpi 2; black; upper edge, base, and apex, white. Antennæ dark-fuscous; in ♂ dentate, apical 1/5 simple. Thorax white; a transverse antemedian line, two posterior dots, and posterior end of crest, black. Abdomen whitish, towards apex pale-grey. Legs fuscous; tarsi and anterior tibiæ annulated with white. Forewings rather narrowly triangular, costa gently arched, apex rounded-rectangular, termen relatively short, slightly bowed, slightly oblique; white, with intricate markings, and some irroration, black; a quadrangular, basal, costal spot connected by a broad oblique streak with dorsum near base; a similar costal spot shortly beyond connected with an irregular spot in disc giving off an oblique posterior process towards costa, and a broad line with an anterior tooth to 1/3 dorsum; this is followed by another spot or series of strigulæ on 1/3 costa; a median costal dot; a broad line from 2/3 costa towards tornus, below middle of disc bent abruptly inwards, and often irregularly blotched, thence wavy to 4/5 dorsum, preceded by a transverse dentate line from dorsum, usually connected in disc with anterior and posterior blotch; several spots or strigulæ on posterior part of costa; an irregular, broad, sometimes blotched, oblique streak from apex, sometimes interrupted; a terminal series of dots, of which one below middle is often larger and triangular; cilia white with black bars. Hindwings broad, termen rounded, slightly waved; whitish; with three, faint, postmedian, grey, transverse lines; cilia whitish with some grey bars. Underside of forewings fuscous; costa with white strigulæ; of hindwings as upperside but darker; a short, broad, transverse, dark-fuscous line, doubly edged with white, from costa before apex.

Mt. Wellington (4,000 ft.), Lake Fenton (3,500 ft.), and Cradle Mountain (3,000 ft.), in January; five specimens.

Gen. Hypsitropha, nov.

ὑψιτροφος, bred on the heights.

Head smooth, with a few projecting scales from lower edge. Tongue well-developed. Palpi moderate, porrect. Antennæ in ♂ slightly dentate, shortly ciliated. Thorax without crest; only slightly hairy beneath. Abdomen not crested. Femora smooth. Posterior tibiæ in ♂ not dilated. Forewings in ♂ without fovea; 10 and 11 arising separately from

cell, 10 sometimes connected with 9, 11 free. Hindwings normal.

Hypsitropha euschema, n.sp.

εὐσχημος, elegant.

♂. 30-32 mm. ♀. 26-30 mm. Head pale-brown. Palpi in ♂ 2¼, in ♀ 3; pale-brown. Antennæ grey; ciliations in ♂ ½. Thorax brown. Abdomen whitish, with a few fuscous scales. Legs brown, mixed with fuscous. Forewings triangular, costa slightly arched near base, thence nearly straight, apex pointed, termen slightly bowed, oblique; whitish, unequally suffused with brown, and sparsely irrorated with fuscous; a blackish line from 1/5 dorsum very obliquely outwards, bent outwards beneath middle of disc, ending shortly above middle; a conspicuous, blackish, discal dot beyond middle; a conspicuous, finely crenulate, blackish line from costa before apex to dorsum before tornus, doubly sinuate, being bent outwards in middle, inwards above and below middle, edged posteriorly with whitish; a fine, interrupted, dark-fuscous, terminal line; cilia whitish, more or less mixed with fuscous. Hindwings rather narrow, termen rounded; whitish; an indistinct pale-fuscous discal dot, and finely dentate postmedian line from ⅔ dorsum; sometimes pale-fuscous transverse strigulæ in terminal area; a pale-fuscous terminal line; cilia as forewings. Underside pale-fuscous; forewings with costal edge brown, strigulated with fuscous; sometimes a darker discal dot, and a short, whitish, subterminal line from costa; hindwings as upper side, but irrorated or strigulated with fuscous, and markings more distinct.

Mt. Wellington (2,500 ft.), Lake Fenton (3,500 ft.), and Cradle Mountain (3,000 ft.), in January; eight specimens.

Dirce oriplancta, n.sp.

ὀριπλαγκτος, mountain-ranging.

♂ ♀. 26-28 mm. Head and thorax dark-fuscous, with a few brownish hairs. Eyes small. Palpi moderate; fuscous mixed with whitish. Antennæ dark-fuscous; in ♂ thickened, ciliations very minute. Abdomen dark-fuscous; apices of segments narrowly whitish. Legs fuscous; tarsi narrowly annulated with whitish. Forewings rather narrowly triangular, costa nearly straight, apex round-pointed, termen slightly bowed, scarcely oblique; fuscous mixed with reddish-brown and whitish; a darker basal patch partly edged with

whitish, a dentate whitish line, edged posteriorly with fuscous, from 1/3 costa to 1/3 dorsum; a fine, indistinct, median, fuscous, transverse line; a sinuate, wavy, white line, edged anteriorly with fuscous, from 2/3 costa to 2/3 dorsum; a white, doubly sinuate, crenulate, subterminal line; a submarginal series of fuscous spots; cilia fuscous, bases irrorated with reddish-brown, apices sharply barred with whitish. Hindwings with termen gently rounded; fuscous; sometimes a whitish central suffusion; cilia fuscous, apices whitish. Underside of forewings fuscous, with whitish discal suffusion, and a short, subterminal, whitish line from costa; of hindwings fuscous, with broad median, postmedian, and subterminal, transverse, whitish lines.

Lake Fenton (3,500 ft.), in January; five specimens, but all except one ♀ (which I have made the type) much worn. The species should be sought a month earlier. It is similar to *D. lunaris*, but without the large, white, sharply-defined blotch on hindwing.

Fam. ŒNOCHROMIDÆ.

Dichromodes diasemaria.

Dichromodes diasemaria, Gn. ix., p. 321.

Panagra exsignata, Wlk. xxiii., p. 1010, *nec* Meyr. P.L.S. N.S.W., 1889, p. 1178.

♂ ♀. 29-32 mm. Head and thorax fuscous. Palpi 3; fuscous; base sharply white. Antennæ fuscous; pectinations in ♂ 3½, apical 1/5 simple. Abdomen dark-grey. Legs fuscous; tarsi with slender whitish annulations; posterior pair grey. Forewings triangular, costa slightly arched at base, thence straight, apex pointed, termen slightly bowed, slightly oblique, crenulate; fuscous-grey; markings dark-fuscous; a short, incomplete, transverse, sub-basal line from costa; a nearly straight line from ¼ costa to 1/3 dorsum, in ♀ partly suffused with brown; a transverse median, discal mark, sometimes pale-centred; a nearly straight, finely dentate line from 2/3 costa to 2/3 dorsum; in ♀ this is usually followed by a whitish-grey fascia; a suffused, doubly sinuate, subterminal line, in ♂ indistinct, in ♀ broad and conspicuous; a pale line follows this; a fine terminal line; cilia fuscous-grey. Hindwings with termen rounded, slightly crenulate; dark-grey, in ♀ often suffused with brownish; terminal line and cilia as forewings. Underside of forewings fuscous, markings obsolete; of hindwings whitish, with dense irroration, discal dot, and subterminal line fuscous.

There is distinct sexual diversity.

St. Helens, Cradle Mountain (3,000 ft.), Zeehan, Strahan,

Dichromodes phæostropha, n.sp.

φαιοστροφος, dark-banded.

♂ ♀. 28-30 mm. Head grey-whitish. Palpi in ♂ 2½, in ♀ 3; dark-fuscous; upper edge grey-whitish; base sharply white. Antennæ fuscous; pectinations in ♂ 4, apical ¼ simple. Thorax grey-whitish, mixed with fuscous. Abdomen grey. Legs dark-fuscous, irrorated, and tarsi annulated with whitish. Forewings triangular, costa slightly arched at base, thence straight, apex rather sharply pointed, termen slightly bowed, slightly oblique, crenulate; grey-whitish with some fuscous irroration; a fuscous, transverse, sub-basal line; a second line from ¼ costa to 1/3 dorsum, similar, but often partly brown; a fuscous median band, darker towards dorsum, containing some brown streaks on veins; anterior edge from 1/3 costa to mid-dorsum, irregularly dentate; posterior edge from 2/3 costa to 2/3 dorsum, incurved above middle, strongly dentate between this and dorsum; an oblong, transverse, discal spot with paler centre in median band, and sometimes obscured by it; an irregular, transverse, fuscous fascia from 5/6 costa to 5/6 dorsum, thickened on and beneath costa, in middle, and on dorsum, preceded by a fine line partly brown, partly fuscous; a suffused fuscous submarginal line; a fine fuscous terminal line; cilia grey-whitish indistinctly barred with fuscous. Hindwings with termen rounded, slightly crenulate; grey; dorsal edge fuscous, barred with grey-whitish; several very obscure pale transverse lines in terminal area; terminal line and cilia as forewings. Underside of forewings grey, markings nearly obsolete; of hindwings whitish, with fuscous irroration, discal dot, and transverse lines.

Rosebery and Strahan in February; nine specimens, also one in Coll. Lyell from Beaconsfield.

Fam. ARCTIADÆ.

Caprimima sicciodes, Hmps.

Cat. Lep. Phal. Suppl., p. 611. Pl. 32, f. 36.

♂ ♀. 20-26 mm. Head and thorax whitish-ochreous. Palpi brown. Antennæ whitish-ochreous; ciliations in ♂ 1½. Abdomen pale-ochreous-grey; tuft whitish-brown. Legs fuscous; posterior pair whitish-ochreous. Forewings triangular, costa rather strongly arched, apex rounded, termen obliquely

rounded; whitish-ochreous slightly brownish-tinged; markings dark-fuscous; costal and median sub-basal spots; a costal spot at 1/6 with submedian spot beneath it; a costal spot at 1/3 giving rise to a thick transverse line, which below middle becomes slender and dentate, and runs to 1/3 dorsum; usually a discal dot, which may be larger and pale-centred, a costal spot before 2/3 giving rise to a fine dentate line, at first inwards, then strongly outwards beneath costa, then sinuate to 2/3 dorsum; a costal spot at ¾ giving rise to a line, which runs close and parallel to preceding; cilia whitish-ochreous, bases spotted with dark-fuscous. Hindwings with termen rounded, wavy; whitish-ochreous, with a pale-grey terminal band variably developed, or wholly grey; cilia ochreous-whitish, sometimes partly grey.

Mt. Wellington (2,500 ft.), Russell Falls, Launceston, and Moina (2,000 ft), in January; Strahan in February; abundant.

Thallarcha epiostola, n.sp.

ἠπιόστολος, softly robed.

♂. 23 mm. Head white; face grey. Palpi dark-fuscous. Antennæ dark-fuscous; in ♂ with short pectinations (1), each with a terminal bristle of equal length. Thorax white, with a transverse dark-fuscous bar before middle. Abdomen whitish, with a median dorsal series of fuscous spots; sides, tuft, and underside pale-ochreous. Legs pale-ochreous; anterior pair fuscous. Forewings triangular, costa moderately arched, apex rounded, termen nearly straight, oblique; white; a broad, fuscous, costal streak from base to ¼, where it terminates abruptly; two parallel, median, dentate, transverse lines, sharply indented anteriorly beneath costa, and more deeply in middle; a short, similar, parallel line from dorsum, not reaching middle; a fuscous dot on ¾ costa and a larger spot at apex; an interrupted submarginal fuscous line; a large, whitish-ochreous, suffused spot in disc at 2/3; a fuscous terminal line; cilia fuscous, on apex white, on tornus whitish-ochreous. Hindwings with termen rounded; whitish-ochreous; a fuscous discal dot towards costa; a fuscous terminal line from apex to middle; cilia whitish-ochreous.

Rather similar to *T. isophragma*, Meyr., but, among other differences, the costal streak is much shorter, and the antennal pectinations longer. In *isophragma* they are scarcely ½.

Launceston in January; one specimen (G. H. Hardy).

Gen. Nesotropha, nov.

νησοτροφος, island-bred.

Tongue short and weakly developed. Palpi rather short, slender, ascending. Antennæ of ♂ with a double row of long pectinations extending to apex. Posterior tibiæ with two pairs of spurs. Forewings with all veins present, 2 from near angle, 3 from angle, 7 free, 8, 9, 10 stalked, 11 from cell, free. Hindwings with all veins present, 3 and 4 approximated or connate at origin, 5, 6, 7 nearly equidistant and parallel.

Nesotropha pygmæodes, n.sp.

πυγμαιωδης, tiny.

♂. 16 mm. Head white. Palpi fuscous. Antennæ whitish; pectinations in ♂ 10, fuscous. Thorax and abdomen fuscous. Legs fuscous; posterior pair grey-whitish. Forewings suboblong, costa strongly arched, apex pointed, termen straight, oblique; white, irrorated and suffused with fuscous; two blackish discal dots at slightly beyond 1/3 and at 2/3; a basal suffusion extending on costa to 1/3; a suffused, moderately broad, median, transverse fascia; a second similar fascia from costa before apex to tornus; cilia fuscous. Hindwings rather elongate, termen rounded; dark-grey; cilia dark-grey.

A very small and obscurely marked species.

Cradle Mountain (3,000 feet), in January; two specimens (W. B. Barnard).

Gen. Phaos.

Phaos, Wlk., Cat. Brit. Mus., iii., p. 627.

Head densely hairy. Tongue very short, aborted. Palpi short, hidden in dense hair. Thorax clothed with long hair above and beneath. Anterior tibiæ with a small terminal claw on inner side. Posterior tibiæ with middle spurs absent, or present and approximated to terminal spurs. Forewings without areole, 7, 8, 9, 10 stalked, 11 separate. Hindwings with 3, 4, 5 approximated at origin, or 4 and 5 connate or stalked, 12 anastomosing with cell to about 2/5.

Type, *P. interfixa*, Wlk. I cannot agree with Hampson in referring this species to the genus *Estigmene*. It appears more closely allied to the New Zealand genus *Metacrias*, which differs only in the presence of a small areole. As all the known examples of *Phaos* are of the male sex, it is probable that the females have the wings incompletely developed as in *Metacrias*. It is quite evident that the stalking of 4 and 5

of the hindwings, and the presence or absence of middle spurs, are not here of generic value.

Phaos interfixa.

Phaos interfixa, Wlk., Cat. Brit. Mus. iii., p. 627.

♂. 30-35 mm. Head dark-fuscous; face usually with a central whitish spot. Palpi dark-fuscous. Antennæ dark-fuscous; pectinations in ♂ 1½. Thorax dark-fuscous; anterior margin, and sometimes edge of shoulder-flaps, whitish. Abdomen dark-fuscous; with five rings on subapical segments, crimson above, whitish beneath; apices of tuft whitish. Legs whitish, mixed with fuscous; femora fuscous, on dorsal surface crimson; posterior tibiæ without middle spurs. Forewings elongate-triangular, costa straight, apex round-pointed, termen bowed, oblique; dark-fuscous; a crimson subcostal streak from base to ¼, separated by a whitish line from costal edge, which is dark-fuscous; numerous whitish spots; a longitudinal series of three elongate spots from near base to ¾, slightly above middle; two elongate spots on fold between base and ½; an inwardly oblique line of four small spots from beneath last median spot to above ¾ dorsum; dorsum broadly dark-fuscous; a subterminal series of small spots, partly confluent with a series of short whitish streaks running into termen; cilia fuscous. Hindwings broad, termen gently rounded; 4 and 5 separate (10 examples) or stalked (one example); whitish or pale-ochreous; some fuscous suffusion at base, which sometimes extends over whole of disc, obscuring markings; a large roundish or oval dark-fuscous discal spot, its posterior edge sometimes produced to an angle; a dark-fuscous terminal band containing some marginal irroration or small suffused spots, whitish or pale-ochreous; cilia fuscous, mixed with whitish or pale-ochreous, wholly the latter on dorsum. Underside whitish or pale-ochreous; forewings with subcostal crimson streak broader, and reaching discal spot at 2/3; both wings with large discal spots and terminal band dark-fuscous; outer half of band on forewings barred with whitish; disc sometimes more or less suffused with fuscous.

Mt. Wellington, Cradle Mountain (3,000 ft.), in January; eleven specimens.

Walker's description certainly refers to this species. So, apparently, does that of Hampson, Cat. Lep. Phal. iii., p. 339, but his figure, Pl. 47, f. 18, is that of the following

species. There are three allied species, which may be easily distinguished as follows:—

Forewings with dorsum dark-fuscous .. .. *interfixa*
Forewings with dorsum orange-ochreous .. .. *acmena*
Forewings with dorsum with alternate bars of blackish and ochreous .. .. *aglaophara*

The third species is from Mt. Kosciusko, New South Wales, and a description of it is being published elsewhere.

Phaos acmena, n.sp.

ἀκμηνος, vigorous.

♂. 32-36 mm. Head dark-fuscous; face, except lateral margins, whitish. Palpi, bases dark-fuscous, apices whitish. Antennæ dark-fuscous; pectinations in ♂ 1½. Thorax dark-fuscous; anterior margin, a longitudinal median line, and edges of shoulder-flaps, whitish. Abdomen, dorsum crimson, with a broad median dark-fuscous band; underside whitish. Legs fuscous, mixed with whitish; femora crimson-ochreous; posterior tibiæ with middle spurs. Forewings elongate-triangular, costa straight, apex rounded, termen bowed, slightly oblique; whitish-ochreous; costal edge whitish-ochreous; a crimson subcostal streak from base to ¼; dorsal edge orange-ochreous; an irregular, broad, dark-fuscous subdorsal line from base to tornus; a similar but more slender median line from base, deflected downwards beyond middle to above tornus; these are crossed by three transverse lines; first at ¼, tolerably straight; second from beneath midcosta, at first curved outwards, then sinuate to above mid-dorsum, interrupted beneath costa by a short, broad, longitudinal orange streak; third from beneath ¾ costa to above ¾ dorsum, slightly sinuate, constricted or narrowly interrupted on veins; a large discal spot beneath mid-costa, sometimes divided into three lobes; a terminal dark-fuscous band, barred by short whitish streaks; cilia dark-fuscous at bases, apices whitish. Hindwings broad, termen gently rounded; 4 and 5 stalked; orange-ochreous; some basal suffusion, a large discal spot, and a broad band along costa and termen, dark-fuscous; the terminal band is indented in middle, and contains one or two orange-ochreous spots; cilia with bases dark-fuscous, apices orange-ochreous. Underside orange-ochreous; both wings with dark-fuscous discal spot and terminal band; band on forewings contains a transverse orange-ochreous line, and three or four whitish bars beneath costa; band on hindwing

contains three orange-ochreous spots partly confluent on termen; basal subcostal streak on forewings very short.

Bothwell in February (W. B. Barnard); Launceston in February (F. M. Littler); six specimens.

Fam. NOLIDÆ.

Celama tholera, n.sp.

θολερος, muddy.

♀. 21 mm. Head and thorax white. Palpi 6; white, irrorated with fuscous. Antennæ pale-grey, toward base whitish. Abdomen whitish. Legs whitish; anterior pair irrorated with fuscous. Forewings triangular, costa gently arched, apex round-pointed, termen slightly bowed, oblique; fuscous-brown; basal area suffused with white; a broad median transverse fascia, edged posteriorly by an oblique white line from 5/6 costa to 2/3 dorsum; a very indistinct, wavy, whitish subterminal line; cilia fuscous-brown. Hindwings with termen slightly rounded; whitish; slightly suffused with grey on termen; cilia whitish, with slight grey suffusion around apex.

Wilmot in February; one specimen.

Nola macrorrhyncha, n.sp.

μακρορρυγκος, long-nosed.

♂ ♀. 26-28 mm. Head and thorax whitish, irrorated with grey. Palpi 8; grey, irrorated with whitish. Antennæ whitish; in ♂ bipectinate, apical 1/8 simple, pectinations 3. Abdomen whitish. Legs grey; posterior pair whitish. Forewings strongly dilated posteriorly, costa gently arched, apex round-pointed, termen slightly bowed, oblique; costal retinaculum of ♂ long, slender, bar-shaped; grey, with some whitish suffusion; subcostal tufts near base, at 1/3, and middle, the last nearer costa, anteriorly grey, posteriorly whitish; a short oblique, fuscous streak on costa at ¼; a similar streak on midcosta, giving rise to a postmedian line of short fuscous streaks on veins, at first outwardly oblique and indistinct beneath costa, thence outwardly curved, sinuate to mid-dorsum, indistinct towards dorsum; similar interneural streaks in posterior part of disc, and a third series running into termen; cilia grey. Hindwings with termen rounded; whitish; cilia whitish.

Hobart in March; Mt. Wellington in February; three specimens. Type in Coll. Lyell. The antennal structure of ♂ is a good distinguishing character.

Fam. NOCTUIDÆ.

Dasygaster pammacha, Turn.

♀. 40-48 mm. (The dimensions are incorrectly given in my description.) Forewings with a blackish median streak from base to ¼, sometimes included in a broad suffused dark-fuscous median band extending to termen; a strongly dentate, dark-fuscous, transverse line from ¼ costa to mid-dorsum, interrupted beneath costa; connected above and below interruption with a sharply dentate line from 3/5 costa to mid-dorsum; these transverse lines are obscured by the median band, when this is developed.

Lake Fenton (3,500 ft.) and Cradle Mountain (3,000 ft.), in January.

Euplexia calliphæa, n.sp.

καλλιφαιος, beautifully dark.

♂ ♀. 44-46 mm. Head and thorax blackish, with a few white scales; white spots encircling bases of antennæ. Palpi 1½; blackish mixed with white. Antennæ blackish. Abdomen dark-fuscous. Legs dark-fuscous; posterior pair irrorated, and all tarsi annulated with whitish. Forewings triangular, costa slightly arched, apex round-pointed, termen bowed, oblique, crenulate; blackish, with a few scattered white scales; orbicular very slenderly outlined with white, broadly and transversely oval; reniform oblong, white with included blackish dots, anterior and posterior margins defined with white, upper and lower margins open, two short white streaks on veins from its posterior inferior angle; three equidistant white dots on posterior fourth of costa; some subterminal white irroration, forming suffused spots beneath apex and below middle; cilia blackish, bases, apices, and narrow bars opposite veins ochreous-whitish. Hindwings with termen gently rounded, crenulate; fuscous; cilia fuscous. Underside fuscous; forewings with a whitish dot in disc at 2/3; hindwings suffused with whitish, except a discal spot, and broad terminal band.

Bothwell and Moina (2,000 ft.), in January; two specimens.

Fam. ANTHELIDÆ.

Anthela pyrrhobaphes, n.sp.

πυρροβαφης, suffused with red.

♂. 36-40 mm. ♀. 43-44 mm. Head and palpi dark-reddish. Antennæ white; pectinations ochreous-fuscous.

Thorax ochreous-reddish. Abdomen reddish. Legs reddish; tarsi ochreous-whitish. Forewings triangular, costa straight, apex sharply pointed, termen straight in apical half, thence rounded; dark-reddish; markings fuscous; a discal spot beyond middle with whitish centre; antemedian line obsolete, just traceable near dorsum; postmedian distinct, rather broadly suffused, from 4/5 costa to 2/3 dorsum; a more slender, curved, subterminal line; cilia reddish. Hindwings with termen slightly rounded; as forewings, but discal spot indistinct. Underside similar; discal spot of hindwings distinct in ♂, beneath costa at about middle, white-centred.

More dusky than *A. ferruginosa*, and with quite differently shaped forewings in the ♂. In that species costa and dorsum of ♂ forewings are of nearly equal length, in this dorsum is about 2/3.

Zeehan in February; four specimens.

Anthela phæozona, n.sp.

φαιοζωνος, dark-girdled.

♀. 68 mm. Head ochreous-grey. Thorax grey, anteriorly ochreous-tinged. Abdomen grey. Forewings triangular, costa straight, apex pointed, produced, termen strongly sinuate, oblique; grey; a fuscous line from ¼ to 1/3 dorsum, outwardly curved, indented posteriorly beneath costa; a broadly suffused brownish-fuscous, outwardly-curved line from costa before middle, joining first line on dorsum; discal spots before and after middle, finely cutlined with fuscous, pale-centred; a broad postmedian fuscous fascia from ¾ costa to ¾ dorsum, its anterior edge sinuate, an included pale line near and parallel to this edge, posterior edge slightly outwardly-curved, strongly crenulate; cilia grey, apices ochreous-tinged. Hindwings with termen rounded; as forewings, but without discal spots. Underside ochreous-grey; forewings with two, hindwings with one discal spot, both wings with postmedian and fine, crenulate, subterminal fuscous lines.

Bothwell in March; one specimen (W. B. Barnard).

Fam. ZYGÆNIDÆ.

Pollanisus calliceros, n.sp.

καλλικερως, with beautiful horns.

♂. 16-20 mm. Head, thorax, and abdomen shining metallic green or bluish-green. Palpi fuscous. Antennal

stalk green or bluish-green; pectinations in ♂ 8, clubbed, fuscous. Legs fuscous, more or less suffused with green lustre. Forewings obovate, broadening towards termen, apex very obtusely rounded; shining metallic green or bluish-green; cilia fuscous. Hindwings moderately broad, apex very obtusely rounded; 3 and 4 separate; fuscous; cilia fuscous.

Easily recognised by the short rounded forewings and ♂ antennæ. The ♀ must be very retired in its habits, for I have never seen one.

Moina (2,000 ft.), in January; seven specimens. Also from Ebor (4,000 ft.), New South Wales, in January and February; twelve specimens.

Fam. CRAMBIDÆ.

Talis invalidella, Meyr.

I now consider that *T. eucraspeda*, Turn., is a synonym. The species varies considerably in the detailed development of the markings on the forewings, and Meyrick's description was taken from a single Tasmanian example. The species has a wide range.

Hobart; one specimen in January. Also from Geelong, Gisborne, and Dunkeld, Victoria; Glen Innes, New South Wales; and Warwick, Queensland.

Talis orthotypa, Turn.

Palpi extremely long (7 or 8); pale-fuscous, lower edge in basal half whitish.

Lake Fenton (3,500 ft.) and Moina (2,000 ft.), in January; Rosebery and Strahan in February; seven specimens. Described from a single specimen without palpi from Katoomba. New South Wales.

Fam. PYRALIDÆ.

Catamola tholoëssa, n.sp.

θολοεις, turbid.

♂. 22 mm. Head fuscous. Palpi of ♂ ascending, closely applied to frons, well exceeding vertex, second joint not dilated; fuscous. Antennæ fuscous; in ♂ with short basal process, not reaching middle of thorax, ciliations ½. Thorax and abdomen fuscous. Legs fuscous; posterior pair fuscous-whitish. Forewings triangular, costa moderately arched, apex

round-pointed, termen bowed, oblique; in ♂ with a small glandular thickening on costa at about 3/5; fuscous; darker antemedian and postmedian transverse lines; cilia whitish, mixed with fuscous. Hindwings with termen rounded; pale fuscous; cilia fuscous-whitish.

Owing to the poor condition of the type, which is in Coll. Lyell, the description of the wing-markings is loosely drawn, but the species should be easily recognised by the small glandular thickening on costa of forewing.

Hobart in March; one specimen.

Epipaschia amauropis, n.sp.

ἀμαυρωπις, obscure.

♀. 30 mm. Head and thorax brown. Palpi ascending, 4, second joint very long, much exceeding vertex, terminal joint very short; brown mixed with dark fuscous. Antennæ fuscous. Abdomen grey-whitish. Legs fuscous; tarsi with whitish annulations; posterior pair except tarsi whitish, irrorated with reddish and dark-fuscous. Forewings elongate-triangular, costa slightly arched, apex rounded-rectangular, termen bowed, slightly oblique; pale reddish-brown, mixed with whitish; a reddish-brown and fuscous discal dot beneath midcosta; an antemedian transverse line at ¼, straight indistinct; postmedian line very slender, whitish, finely dentate, from 2/3 costa obliquely outwards, forming a quadrate, median, posterior projection, thence bent inwards to ⅔ dorsum, an interrupted, fuscous terminal line; cilia whitish, mixed with reddish, with some incomplete fuscous bars. Hindwings with termen rounded; whitish-grey, darker towards termen; cilia whitish with an antemedian fuscous line.

Strahan in February; one specimen.

Fam. PYRAUSTIDÆ.

Scoparia plagiotis, Meyr.

♂ ♀. 22-25 mm. This species varies much in the development of blackish streaks on the forewings. *S. ochrophara*, Turn., is a form, found also in Tasmania, in which these are well developed, and the reniform is obscured by a blackish streak or small blotch.

Hobart, Bothwell, Campbell Town, Wilmot, Moina (2,000 ft.), Rosebery, Zeehan, Strahan. Also from Mt. Kosciusko (3,000 to 3,500 ft.), New South Wales (type *ochrophara*); and Gisborne, Victoria.

A REVISION OF THE LEPIDOPTERA OF TASMANIA.

By

A. JEFFERIS TURNER, M.D., F.E.S., Brisbane.

(Read 12th October, 1925.)

Tasmania is rich in Lepidoptera. The species are numerous, very interesting, but have been very little studied. There is a great want of resident collectors and observers, and it is to encourage these that this revision has been planned. The classification adopted is that used in Dr. Tillyard's recent book. It is a revision of species only; no notice is taken of local races (usually, but unfortunately, called subspecies). To each genus and species is added the name of its author. Synonyms are excluded, and after each species there is given a single reference, not necessarily to the original description, but to the best available description for the local student. On reference to this, the synonymy and other particulars will usually be found. Where this description appears under another name, that name is added in brackets. Genera and species which have not been recorded outside Tasmania are distinguished by a *. These restrictions have been necessary to secure brevity. Should this revision accomplish its purpose it will soon become obsolete, but a list of additions may be published subsequently. To this end, I shall be pleased to correspond with and name specimens for local collectors. Only the first half of the revision is published this year; we hope to complete the second half in next year's Proceedings.

For our species and localities we are indebted to various sources. The most considerable is the papers of Mr. Edw. Meyrick, F.R.S., who collected extensively in the island during the summer of 1882-83. His localities were Hobart, Mount Wellington, Campbell Town, George's Bay (St. Helens), Launceston, and Deloraine. Next to this in importance are the results of a six weeks' tour in January and February,

1925, mainly devoted to the mountains and west coast, by Mr. W. B. Barnard, of Toowoomba, Queensland, and myself, the localities being Hobart, Mount Wellington, Russell Falls and Lake Fenton (3,500 ft.), in the National Park, Launceston, Wilmot, Moina (2,000 ft., on the Cradle Mountain Road, 17 miles from Wilmot, and near the small mining township of that name), Cradle Mountain (3,000 ft.), Burnie, Rosebery (17 miles north of Zeehan), Zeehan, and Strahan. After my departure Mr. Barnard collected for a few weeks in Launceston, near Beaconsfield, Ross, and Bothwell. Among resident collectors we may mention H. H. Griffith, J. B. Norman (Strahan), W. K. Findlay (Zeehan), G. J. Latta (Launceston), A. M. Lea (Hobart), Mrs. Lodder (Ulverstone), and G. H. Hardy (Hobart). On a larger scale was F. M. Littler's collection, now in the South Australian Museum, to the trustees of which and to Mr. N. B. Tindale I am much indebted for a list of species and localities and the loan of some specimens for examination. Littler's localities were Launceston, Beaconsfield (Kelso), George Town (Lefroy), St. Mary's, and St. Helens. Our locality records are, of course, very far from exhaustive. A species recorded from one locality may be expected to occur in any other with similar vegetation, altitude, rainfall, etc. Species recorded from three or more localities are probably generally distributed. Where no locality is given the species has been recorded simply from Tasmania.

A general discussion of the fauna would be impossible in this place, but a few observations may be allowed. Tasmania was united to the mainland during the lifetime of existing species in Pleistocene times. A period of glaciation, which occurred during this connection, covered the mountains with snowfields, while the lower areas supported a fauna which has since then been restricted to alpine regions. In this way we explain the occurrence of a number of identical species in the widely separated areas of Cradle Mountain and the Australian Alps. Much of the old Tasmanian fauna, not able to withstand these rigorous conditions, must have been driven northwards, to return with the resumption of a milder climate, probably with some impoverishment, which was compensated by a large immigration of Australian forms. The whole fauna is now preponderatingly Australian, but a relatively small proportion of peculiarly Tasmanian forms still survive, mostly in the mountains.

The following is a list of contractions employed in the references:—

Ann. Mag. Nat. Hist.	Annals and Magazine of Natural History.
Brit. Lep.	Meyrick. Handbook of British Lepidoptera.
Cat. Brit. Mus.	Walker. List of Lepidopterous Insects in British Museum.
Cat. Lep. Phal.	Hampson. Catalogue of the Lepidoptera Phalænæ.
Delt. & Pyr.	Guenée. Deltoides et Pyralites.
Exot. Micro.	Meyrick. Exotic Microlepidoptera.
Noct.	Guenée. Noctuélites.
Prodr. Zool. Vic.	McCoy. Prodromus to Zoology of Victoria.
P.L.S.N.S.W.	Proceedings of the Linnean Society of New South Wales.
P.R.S.Q.	Proceedings of the Royal Society of Queensland.
P.R.S. Tas.	Proceedings of the Royal Society of Tasmania.
P.R.S. Vic.	Proceedings of the Royal Society of Victoria.
P. Zool. Soc.	Proceedings of the Zoological Society of London.
Tr. E.S.	Transactions of the Entomological Society of London.
Tr. N.Z. Inst.	Transactions of the New Zealand Institute.
Tr. R.S.S.A.	Transactions of the Royal Society of South Australia.
W. & L.	Waterhouse and Lyell. The Butterflies of Australia.

LEPIDOPTERA HETERONEURA.

RHOPALOCERA.

NYMPHALOIDEA.

LYCÆNIDÆ.

Lycæninæ.

Candalides, Hb.

acasta, Cox. W. & L., p. 81. Hobart; Beaconsfield; Strahan.

Zizina, Chapman.

labradus, Godart. W. & L., p. 105. Hobart; Bothwell; Launceston; Beaconsfield.

Neolucia, W. & L.

agricola, Westw. W. & L., p. 107. Hobart; Mt. Wellington; Russell Falls; Launceston; Waratah; Zeehan; Strahan.

hobartensis, Miskin. W. & L., p. 108. Mt. Wellington, 4,000 ft.; Moina, 2,000 ft.; Middlesex Plains, 2,500 ft.; Cradle Mt., 3,000 ft.

mathewi, Miskin. W. & L., p. 108. Flinders Island.

Theclinæ.

Paralucia, W. & L.

aurifer, Blanchard. W. & L., p. 112. Hobart; Launceston; George Town; St. Mary's.

Pseudalmenus, Druce.

chlorinda, Blanchard. W. & L., p. 113. Hobart; Launceston.

[PIERIDIDÆ. Several examples of *Anaphæis java*, Sparrman, and at least one of *Appias paulina*, Cram., both common Australian species, have been taken on the north coast of Tasmania. These appear to be casual immigrants, either on their own wings assisted by northerly winds, or conveyed on steamers, and not genuine residents.]

NYMPHALIDÆ.

Satyrinæ.

Heteronympha, Wlgrn.

merope, Fab. W. & L., p. 37. Hobart, Launceston; Beaconsfield; Burnie; Flinders Island.

philerope, Bdv. W. & L., p. 39. Hobart; Ross; Launceston; Moina, 2,000 ft.; Burnie; Mt. Magnet.

cordace, Hb. W. & L., p. 40. Moina, 2,000 ft.; Zeehan; Strahan.

**Nesoxenica*, W. & L.

**leprea*, Hew. W. & L., p. 35. Mt. Wellington, 2,500 ft.; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Mt. Dundas; Mt. Magnet.

Argynnina, Butl.

**hobartia*, Westw. W. & L., p. 40. Hobart; Mt. Wellington; Launceston; Latrobe.

**tasmanica*, Lyell. W. & L., p. 41. Zeehan; Strahan.

Oreixenica, W. & L.

lathoniella, Westw. W. & L., p. 42. Hobart; Mt. Wellington; Bothwell; Launceston; Beaconsfield; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Ulverstone; Burnie; Mt. Magnet.

**laranda*, W. & L. W. & L., p. 42. Zeehan; Strahan; Mt. Magnet.

orichora, Meyr. W. & L., p. 43. Middlesex Plains, 2,500 ft.; Cradle Mt., 3,000 ft.

Xenica, Westw.

klugi, Guerin. W. & L., p. 44. Hobart; Russell Falls; Brighton; Bothwell; Launceston; Beaconsfield; George Town; Sheffield; Burnie; Rosebery; Zeehan; Strahan.

Nymphalinæ.

Precis, Hb.

villida, Fab. W. & L., p. 54. Launceston; George Town; Burnie.

Pyrameis, Hb.

cardui, Lin. W. & L., p. 56. Launceston; St. Mary's; Zeehan.

itea, Fab. W. & L., p. 56. Bothwell; Lottah; Launceston; Burnie; Mt. Magnet.

PAPILIONOIDEA.

PAPILIONIDÆ.

Papilio, Lin.

macleayanus, Leach. W. & L., p. 166. Hobart; Launceston; Mt. Magnet.

HESPEROIDEA.

HESPERIDÆ.

Trapezetinæ.

Anisynta, Low.

cliena, Hew. W. & L., p. 176. Hobart; Deloraine.

lutea, Tepper. W. & L., p. 177. Hobart; Launceston; George Town.
tasmanica, Miskin. W. & L., p. 183. Hobart; Bagdad; Launceston; Beaconsfield; George Town; Mt. Magnet.

Hesperilla, Hew.
chaostola, Meyr. W. & L., p. 187. Hobart; Huonville; Bridport.
donnysa, Hew. W. & L., p. 188. Hobart; Mt. Wellington; Cygnet; Scottsdale; Cradle Mt., 3,000 ft.; Mt. Magnet; Zeehan; Strahan.
idothea, Miskin. W. & L., p. 187. Hobart; Geeveston; Scottsdale; Strahan.
cyclospila, M. & L.. W. & L., p. 188. Bridport; Latrobe.

Motasingha, Watson.
dominula, Ploetz. W. & L., p. 197. Bothwell; Ross; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Mt. Magnet; Strahan.

Erynninæ.

Taractrocera, Butl.
papyria, Bdv. W. & L., p. 200. Hobart; Triabunna; Rosebery; Strahan.

Padraona, Moore.
lascivia, Rosen. W. & L., p. 202. Hobart.
flavovittata, Latr. W. & L., p. 203. Hobart; Triabunna; Launceston; Wynyard.

HETEROCERA.

BOMBYCOIDEA.

SATURNIADÆ.

Antheræa, Hb.
eucalypti, Scott. P.L.S.N.S.W. 1922, p. 355.
helena, White. P.L.S.N.S.W. 1922, p. 355. Launceston.

NOTODONTOIDEA.

LARENTIADÆ.

Euchœca, Hb.
rubropunctaria, Dbld. P.L.S.N.S.W. 1890, p. 811. Hobart; Mt. Wellington; Russell Falls; St. Helens; Launceston.

Pœcilasthena, Warr.

pulchraria, Dbld. P.L.S.N.S.W. 1890, p. 813. Hobart; Mt. Wellington, 2,500 ft.; Tasman Peninsula; St. Helens; Deloraine; Cradle Mt., 3,000 ft.; Burnie.

urarcha, Meyr. P.L.S.N.S.W. 1890, p. 812. Mt. Wellington, 2,500 ft.; Deloraine.

**euphylla*, Meyr. P.L.S.N.S.W. 1890, p. 815. Hobart; Mt. Wellington, 2,500 ft.; Deloraine.

anthodes, Meyr. P.L.S.N.S.W. 1890, p. 816. Rosebery.

**ædœa*, Turn. P.R.S. Tas. 1925. Rosebery; Strahan.

xylocyma, Meyr. P.L.S.N.S.W. 1890, p. 814. Mt. Wellington, 2,500 ft.; Russell Falls.

Chloroclystis, Hb.

catastreptes, Meyr. P.L.S.N.S.W., 1890, p. 797. Launceston.

testulata, Gn. P.L.S.N.S.W. 1890, p. 798. Hobart; Mt. Wellington, 2,500 ft.; St. Helens; Deloraine.

approximata, Wlk. P.L.S.N.S.W. 1890, p. 799 (*pyrctodes*). St. Helens.

laticostata, Wlk. P.L.S.N.S.W. 1890, p. 801. Hobart; Launceston.

filata, Gn. P.L.S.N.S.W. 1890, p. 795. Hobart; Mt. Wellington, 2,500 ft.; Lake Fenton, 3,500 ft.; Launceston; Deloraine; Strahan.

Chætolopha, Warr.

leucophragma, Meyr. P.L.S.N.S.W. 1890, p. 818. Russell Falls; Launceston; Wilmot; Moina, 2,000 ft.; Burnie.

Microdes, Gn.

villosata, Gn. P.L.S.N.S.W. 1890, p. 802. Hobart; Mt. Wellington, 2,500 ft.; Russell Falls; Lake Fenton, 3,500ft.; Launceston; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Strahan.

squamulata, Gn. P.L.S.N.S.W. 1890, p. 803. Hobart; Russell Falls; Bothwell; Launceston.

**hæmobaphes*, Turn. P.R.S. Tas. 1925. Lake Fenton, 3,500 ft.

typhopa, Low. Tr. R.S.S.A. 1897, p. 50.

**melanocausta*, Meyr. P.L.S.N.S.W. 1890, p. 803. Mt. Wellington, 2,500 ft.; Deloraine.

diplodonta, Turn. P.R.S. Vic. 1903, p. 239. Mt. Wellington, 2,500 ft.

Eccymatoge, Prout.

callizona, Low. P.L.S.N.S.W. 1890, p. 855 (*brujata*). Mt. Wellington, 2,500 ft.; Russell Falls; Beaconsfield.

iopolia, Turn. P.R.S. Tas. 1925. Cradle Mt., 3,000 ft.

Horisme, Hb.

moriuata, Gn. P.L.S.N.S.W. 1890, p. 853. Hobart; St. Helens.

leucophanes, Meyr. P.R.S. Tas. 1925. Mt. Wellington, 2,500 ft.; Lake Fenton, 3,500 ft; St. Helens; Beaconsfield; Deloraine; Rosebery; Strahan.

Eucymatoge, Hb.

liometopa, Turn. P.R.S. Tas. 1925. Russell Falls

Cidaria, Treit.

apotoma, Turn. P.L.S.N.S.W. 1906, p. 706.

uncinata, Gn. P.L.S.N.S.W. 1890, p. 850. Hobart; St. Helens; Launceston; Beaconsfield; Strahan.

microcyma, Meyr. P.L.S.N.S.W. 1890, p. 846. Tasman Peninsula; Campbell Town; St. Helens.

subochraria, Dbld. P.L.S.N.S.W. 1890, p. 851. Hobart; Bothwell; St. Helens; Launceston; Deloraine; Sheffield; Rosebery; Strahan.

Larentia, Treit.

epicrossa, Meyr. P.L.S.N.S.W. 1890, p. 871. Mt. Wellington; Deloraine; Moina, 2,000 ft.; Cradle Mt., 3 000 ft.; Rosebery; Zeehan; Strahan.

cheimatobiata, Gn. P.R.S. Vic. 1903, p. 274. Hobart; Mt. Wellington; Brighton; Moina, 2,000 ft.

Epirrhoë, Hb.

eustropha, Turn. P.R.S. Tas. 1925. Mt. Wellington, 2,500 ft.

callima, Turn. P.R.S. Tas. 1925. Cradle Mt., 3,000 ft.; Strahan.

Melitulias, Meyr.

graphicata, Meyr. P.L.S.N.S.W. 1890, p. 857. Tasman Peninsula; Bridport; Launceston; Beaconsfield; Deloraine; Ulverstone; Cradle Mt., 3,000 ft.; Rosebery; Zeehan; Strahan.

leucographa, Turn. Tr. R.S.S.A. 1922, p. 247. Lake Fenton, 3,500 ft.

glandulata, Gn. P.L.S.N.S.W. 1890, p. 858. Hobart; Mt. Wellington; Bothwell; Swansea; St. Helens; Moina, 2,000 ft.; Strahan.

Euphyia, Hb.

interruptata, Gn. P.L.S.N.S.W. 1890, p. 825. Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

epicteta, Turn. P.L.S.N.S.W. 1907, p. 633. Mt. Wellington, 2,500 ft.; Russell Falls; Launceston; Wilmot; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Rosebery; Strahan.

**psarodes*, Turn. P.R.S. Vic. 1903, p. 253. Mt. Wellington, 2,500 ft.; Lake Fenton, 3,500 ft.; Cradle Mt., 3,000 ft.; Strahan.

lucidulata, Wlk. P.L.S.N.S.W. 1890, p. 827. Tasman Peninsula; Launceston; Deloraine; Wilmot; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Rosebery; Zeehan; Strahan.

conifasciata, Butl. P.L.S.N.S.W. 1890, p. 828. Hobart; Mt. Wellington, 2,500 ft.; Russell Falls; Sheffield; Wilmot; Moina, 2,000ft.; Rosebery; Zeehan.

percrassata, Wlk. P.L.S.N.S.W. 1890, p. 873. Ross.

subrectaria, Gn. P.L.S.N.S.W. 1890, p. 829. Bothwell; Launceston.

lamprotis, Meyr. P.L.S.N.S.W. 1890, p. 833. Bothwell.

anthracinata, Gn. P.L.S.N.S.W. 1890, p. 830. Hobart; Mt. Wellington, 2,500ft.; Russell Falls; Bothwell; Campbell Town; Launceston; Wilmot; Moina. 2,000 ft.; Cradle Mt., 3,000 ft.; Latrobe; Burnie; Strahan.

strumosata, Gn. P.L.S.N.S.W. 1890, p. 831. Hobart; Mt. Wellington, 2,500 ft.; Russell Falls; St. Helens; Launceston; Deloraine; Cradle Mt., 3,000 ft.; Guildford; Rosebery; Zeehan; Strahan.

vacuaria, Gn. P.L.S.N.S.W. 1890, p. 866. Hobart; Launceston; Beaconsfield.

leptophrica, Turn. Tr. R.S.S.A. 1922, p. 250. Bothwell; Moina, 2,000 ft.

**hilaodes*, Turn. P.R.S. Tas. 1925. Russell Falls; Moina, 2,000 ft.; Rosebery.

[1]*synchora*, Meyr. P.L.S.N.S.W. 1890, p. 835. Hobart.

heteroleuca, Meyr. P.L.S.N.S.W. 1890, p. 837.

excentrata, Gn. P.L.S.N.S.W. 1890, p. 834 (*constipata*).
**heterotropa*, Turn. P.R.S. Tas. 1925. Mt. Wellington, 2,500 ft.; Moina, 2,000 ft.; Middlesex Plains, 2,500 ft.; Cradle Mt., 3,000 ft.
languescens, Rosen. P.L.S.N.S.W. 1890, p. 839. Hobart; Mt. Wellington; Wilmot.
orthropis, Meyr. P.L.S.N.S.W. 1890, p. 840. Mt. Wellington, 2,500 ft.; Cradle Mt., 3,000 ft.
**trissophrica*, Turn. P.R.S. Vic. 1903, p. 259. Mt. Wellington.
chrysocyma, Meyr. P.L.S.N.S.W. 1890, p. 843. Middlesex Plains, 2,500 ft.; Cradle Mt., 3,000 ft.
perornata, Wlk. P.L.S.N.S.W. 1890, p. 844. Mt. Wellington; Bothwell; Moina, 2,000 ft.; Beaconsfield; Cradle Mt., 3,000 ft.; Zeehan.
mecynata, Gn. P.L.S.N.S.W. 1890, p. 845. Hobart; Bothwell; St. Mary's; Launceston; Deloraine.
leucozona, Meyr. P.L.S.N.S.W. 1890, p. 846. Bothwell; Launceston; Deloraine.
ebuleata, Gn. P.L.S.N.S.W. 1890, p. 849. Hobart; Russell Falls; Campbell Town; Launceston; Deloraine; Wilmot; Moina, 2,000 ft.
correlata, Wlk. P.L.S.N.S.W. 1890, p. 848. Russell Falls; Launceston; Wilmot; Cradle Mt., 3,000 ft.
trygodes, Meyr. P.L.S.N.S.W. 1890, p. 851. St. Helens; Launceston; Rosebery; Strahan.
crocota, Turn. P.R.S. Vic. 1903, p. 263. Hobart.
plagiocausta, Turn. P.R.S. Vic. 1903, p. 263. Hobart.
severata, Gn. P.L.S.N.S.W. 1890, p. 854. Hobart; Russell Falls; Campbell Town; St. Helens; Launceston; Cradle Mt., 3,000ft.
squamulata, Warr. P.R.S. Vic. 1903, p. 264. Hobart.

**Aprosdoceta*, Turn.
**orina*, Turn. P.R.S. Tas. 1925. Lake Fenton, 3,500 ft.
**chytrodes*, Turn. P.R.S. Tas. 1925. Lake Fenton, 3,500 ft.

Acodia, Rosen.
pauper, Rosen. P.L.S.N.S.W. 1890, p. 861. Hobart; Mt. Wellington; Russell Falls; Ulverstone.

Xanthorhoë, Hb.
**centroneura*, Meyr. P.L.S.N.S.W. 1890, p. 863. Hobart; Moina, 2,000 ft.

subidaria, Gn. P.L.S.N.S.W. 1890, p. 864. Hobart; Mt. Wellington, 2,500 ft.; Russell Falls; Bothwell; St. Helens; Beaconsfield; Launceston; George Town; Wilmot; Cradle Mt., 3,000 ft.; Burnie; Rosebery; Strahan.

sodaliata, Wlk. Tr. R.S.S.A. 1922, p. 254. Hobart; Launceston.

**bituminea*, Turn. P.R.S. Tas. 1925. Rosebery.

**pyrrhobaphes*, Turn. P.R.S. Tas. 1925. Moina, 2,000 ft.

**amblychroa*, Turn. P.R.S. Tas. 1925. Hobart.

agelasta, Turn. P.R.S. Vic. 1903, p. 270. Launceston.

hyperythra, Low. Tr. R.S.S.A. 1892, p. 12. Wilmot.

brujata, Gn. P.L.S.N.S.W. 1890, p. 868 (*repentinata*). Bothwell; Ulverstone; Burnie.

anaspila, Meyr. P.L.S.N.S.W. 1890, p. 869. Mt. Wellington, 2,500 ft.; Russell Falls; Bothwell; Moina, 2,000 ft.

heliacaria, Gn. P.L.S.N.S.W. 1890, p. 872. Hobart; Bothwell.

vicissata, Gn. P.L.S.N.S.W. 1890, p. 872. Hobart; Mt. Wellington, 2,500 ft.; Bothwell; Ross; Launceston; Moina, 2,000 ft.

**Acalyphes*, Turn.

**philorites*, Turn. P.R.S. Tas. 1925. Cradle Mt., 3,000 ft.

Dasysternica, Turn.

**pericalles*, Turn. Tr. R.S.S.A. 1922, p. 256. Bothwell; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

**bertha*, Swin. P.R.S. Tas. 1925. Mt. Wellington, 3,500-4,000 ft.; Lake Fenton, 3,500 ft.; Cradle Mt.. 3,000 ft.

Dasyuris, Gn.

euclidiata, Gn. P.L.S.N.S.W. 1890, p. 876. Hobart; Bothwell; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

polycarpa, Meyr. P.L.S.N.S.W. 1890, p. 841. Cradle Mt., 3,000 ft.

decisaria, Wlk. P.L.S.N.S.W. 1890, p. 875. Mt. Wellington; Launceston.

hedylepta, Turn. P.R.S. Vic. 1903, p. 279. Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

Notoreas, Meyr.

**æthalopa*, Turn. P.L.S.N.S.W. 1906, p. 710. Zeehan.

Sterrhidæ.

Eois, Hb.

albicostata, Wlk. P.L.S.N.S.W. 1906, p. 645 (*costaria*). Hobart; Burnie.

costaria, Wlk. P.L.S.N.S.W. 1887, p. 844 (*albicostata*). Hobart; Launceston; Deloraine.

halmæa, Meyr. P.L.S.N.S.W. 1887, p. 846. Russell Falls; Lake Fenton, 3,500 ft.; St. Helens; Launceston; Wilmot; Burnie; Strahan.

philocosma, Meyr. P.L.S.N.S.W. 1887, p. 845. Hobart; Russell Falls; Bothwell; St. Helens; Launceston; Beaconsfield; Rosebery; Strahan.

Scopula, Schrank.

perlata, Wlk. P.L.S.N.S.W. 1887, p. 860. Mt. Wellington, 2,500 ft.; Russell Falls; Bothwell; Wilmot; Burnie; Rosebery; Zeehan.

liotis, Meyr. P.L.S.N.S.W. 1887, p. 854. Hobart; Great Lake, 3,000 ft.; Moina, 2 000 ft.

rubraria, Dbld. P.L.S.N.S.W. 1887, p. 852. Hobart; St. Helens; Launceston; Sheffield.

optivata, Wlk. P.L.S.N.S.W. 1887, p. 857. Hobart; Deloraine.

Dasybela, Turn.

achroa, Low. P.L.S.N.S.W. 1907, p. 667. Hobart.

Geometridæ.

Julops, Prout.

argocrana, Meyr. P.L.S.N.S.W. 1887, p. 867. Strahan.

Euloxia, Warr.

gratiosata, Gn. P.L.S.N.S.W. 1887, p. 886. Hobart; Great Lake, 3,000 ft.; Launceston; George Town; Cradle Mt., 3,000 ft.; Strahan.

meandraria, Gn. P.L.S.N.S.W. 1887, p. 874. Hobart; Beaconsfield; Rosebery; Zeehan.

fugitivaria, Gn. P.L.S.N.S.W. 1887, p. 876. Launceston; Deloraine.

**leucochorda*, Meyr. P.L.S.N.S.W. 1887, p. 875. Lottah; Launceston; Deloraine; Cradle Mt., 3,000 ft.

Chlorocoma, Turn.

cadmaria, Gn. P.L.S.N.S.W. 1887. p. 886. Hobart; Beaconsfield; George Town; Rosebery; Zeehan; Strahan.

**rhodothrix*, Turn. Tr. R.S.S.A. 1922, p. 273. Cradle Mt., 3,000 ft.; Strahan.

dichloraria, Gn. P.L.S.N.S.W. 1887, p. 884. Hobart; Brighton; St. Helens; Launceston; Beaconsfield; Burnie; Zeehan.

carenaria, Gn. P.L.S.N.S.W. 1910, p. 584. Hobart.

assimilis, Luc. P.L.S.N.S.W. 1910, p. 581. Hobart.

externa, Wlk. P.L.S.N.S.W. 1887, p. 888. Hobart; Deloraine.

melocrossa, Meyr. P.L.S.N.S.W. 1887, p. 879. Hobart; Tasman Peninsula; Deloraine; Rosebery; Strahan.

tetraspila, Low. Tr. R.S.S.A. 1901, p. 66. Beaconsfield.

Gelasma, Warr.

semicrocea, Wlk. P.L.S.N.S.W. 1887, p. 887. Hobart; Mt. Wellington, 2,500 ft.; Lake Fenton, 3,500 ft.; Beaconsfield.

calaïna, Turn. P.L.S.N.S.W. 1910, p. 600. Rosebery.

centrophylla, Meyr. P.L.S.N.S.W. 1887, p. 880. Mt. Wellington, 2,500 ft.; St. Helens; Beaconsfield; George Town.

Eucyclodes, Warr.

insperata, Wlk. P.L.S.N.S.W. 1887, p. 895. St. Helens.

buprestaria, Gn. P.L.S.N.S.W. 1887, p. 890. Cygnet; Launceston.

Apodasmia, Turn.

rufonigraria, Wlk. P.L.S.N.S.W. 1887, p. 916.

Chlorodes, Gn.

boisduvalaria, Le Guil. P.L.S.N.S.W. 1887, p. 892. Hobart; Launceston; Beaconsfield; Rosebery.

Cyneoterpna, Prout.

wilsoni, Feld. P.L.S.N.S.W. 1887, p. 906. Russell Falls.

Crypsiphona, Meyr.

occultaria, Don. P.L.S.N.S.W. 1887, p. 903. Hobart; Tasman Peninsula; Cygnet; Launceston; Wilmot.

Heliomystis, Meyr.

electrica, Meyr. P.L.S.N.S.W. 1887, p. 900. St. Mary's.

BOARMIADÆ.

Diastictis, Hb.

australiaria, Gn. P.L.S.N.S.W. 1891, p. 587. Hobart; Swansea; Launceston; Deloraine.

Melanodes, Gn.

anthracitaria, Gn. P.L.S.N.S.W. 1891, p. 622. Hobart; Zeehan.

Ectropis, Hb.

fractaria, Gn. P.L.S.N.S.W. 1891, p. 629. Hobart; St. Helens; Launceston; Sheffield.

subtinctaria, Wlk. P.L.S.N.S.W. 1891, p. 628. Launceston; Ulverstone.

excursaria, Gn. P.L.S.N.S.W. 1891, p. 609. Hobart; St. Helens; Launceston; Ulverstone; Strahan.

despicata, Wlk. P.L.S.N.S.W. 1891, p. 612. Hobart; Mt. Wellington; Launceston; Sheffield; Wilmot; Rosebery.

exsuperata, Wlk. P.L.S.N.S.W. 1891, p. 628. Beaconsfield; Ulverstone.

Boarmia, Treit.

lyciaria, Gn. P.L.S.N.S.W. 1891. p. 604. Hobart; Bothwell; Ross; Launceston; Zeehan.

**epiphlœa*, Turn. P.R.S. Tas. 1925. Moina, 2,000 ft.; Zeehan; Strahan.

cognata, Wlk. P.L.S.N.S.W. 1891, p. 606. Hobart; Launceston; Deloraine.

destinataria, Gn. P.L.S.N.S.W. 1891, p. 613..

**epiconia*, Turn. P.R.S. Tas. 1925. Mt. Wellington, 3,000 ft.

**proschora*, Turn. P.R.S. Tas. 1925. Zeehan.

**atycta*, Turn. P.R.S. Tas. 1925. Lake Fenton, 3,500 ft.

Syneora, Turn.

mundifera, Wlk. P.L.S.N.S.W. 1891, p. 598 (*silicaria*). Launceston; Strahan.

**symphonica*, Turn. P.R.S. Tas. 1925. Hobart; Beaconsfield; Moina, 2,000 ft.; Rosebery.

strixata, Wlk. P.L.S.N.S.W. 1891, p. 598 (*cheleuta*). Beaconsfield.

Psilosticha, Meyr.

mactaria, Gn. P.L.S.N.S.W. 1891, p. 624. Hobart; St. Helens.

Osteodes, Gn.

procurata, Wlk. P.L.S.N.S.W. 1891, p. 589. Hobart.

Cleora, Curtis.

bitæniaria, Le Guil. P.L.S.N.S.W. 1891, p. 616. Hobart; Campbell Town; Launceston.

**nesiotis*, Turn. P.R.S. Tas. 1925. Rosebery.

Lyelliana, Turn.
**pristina*, Turn. P.R.S. Tas. 1925. Cradle Mt., 3,000 ft.

Metrocampa, Latr.
biplaga, Wlk. P.L.S.N.S.W. 1891, p. 644 (*glaucias*). Russell Falls; Beaconsfield; Ulverstone; Strahan.
ada, Butl. P.L.S.N.S.W. 1891, p. 645. Hobart; Launceston.

Lomographa, Hb.
**odontocrossa*, Turn. Tr. R.S.S.A. 1906, p. 134. Strahan.
icasta, Turn. P.L.S.N.S.W. 1919, p. 261. Hobart; Rosebery; Strahan.

Casbia, Wlk.
**œnias*, Meyr. P.L.S.N.S.W. 1891, p. 637. St. Helens.
alphitopis, Turn. P.L.S.N.S.W. 1919, p. 269. Mt. Wellington, 2,500 ft.; Strahan.
eccentritis, Meyr. P.L.S.N.S.W. 1891, p. 635. Mt. Wellington, 2,500 ft.; Russell Falls; Launceston; Burnie; Strahan.
sciagrapha, Turn. P.L.S.N.S.W. 1919, p. 271. Great Lake, 3,000 ft.

Rhinodia, Gn.
rostraria, Gn. P.L.S.N.S.W. 1891, p. 640. Hobart.

Idiodes, Gn.
apicata, Gn. P.L.S.N.S.W. 1891, p. 643. Hobart; Tasman Peninsula; Lake Fenton, 3,500 ft.; St. Helens; Ulverstone; Burnie.

Planolocha, Meyr.
obliquata, Luc. P.R.S.Q. 1892, p. 80. Rosebery.

Neritodes, Gn.
verrucata, Gn. P.L.S.N.S.W. 1891, p. 652. Hobart; Bothwell; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Rosebery; Zeehan; Strahan.

Amelora, Meyr.
sparsularia, Gn. P.L.S.N.S.W. 1891, p. 648. Rosebery.
crenulata, Turn. P.R.S. Tas. 1925. Mt. Wellington, 2,500 ft.; Russell Falls; Cradle Mt., 3,000 ft.
**suffusa*, Turn. P.R.S. Tas. 1925. Mt. Wellington; Lake Fenton, 3,500ft.; Cradle Mt., 3,000ft.

**cyclocentra*, Turn. P.R.S. Tas. 1925. Rosebery; Strahan.

australis, Rosen. P.L.S.N.S.W., 1891, p. 649. Hobart.

catacris, Meyr. P.L.S.N.S.W. 1891, p. 650. Strahan.

milvaria, Gn. P.L.S.N.S.W. 1891, p. 650. Launceston.

arotræa, Meyr. P.L.S.N.S.W. 1891, p. 651. Hobart.

leucaniata, Gn. P.L.S.N.S.W. 1891, p. 651. Rosebery; Zeehan.

oritropha, Turn. P.L.S.N.S.W. 1919, p. 308. Cradle Mt., 3,000 ft.

**oxytona*, Turn. P.R.S. Tas. 1925. Rosebery.

Encryphodes, Turn.

**melanochorda*, Turn. P.L.S.N.S.W. 1919, p. 384. Hobart.

Thalaina, Wlk.

selenæa, Dbld. P.L.S.N.S.W. 1891, p. 653. Hobart; Launceston; Rosebery; Zeehan.

inscripta, Wlk. P.L.S.N.S.W. 1891, p. 655. Mt. Wellington, 1,500 ft.; Bothwell; Launceston; Moina, 2,000 ft.

Mnesampela, Meyr.

comarcha, Meyr. P.L.S.N.S.W. 1891, p. 656. Launceston.

privata, Gn. P.L.S.N.S.W. 1891, p. 658. Bothwell; Launceston; Wilmot; Cradle Mt., 3,000 ft.

fucata, Feld. P.L.S.N.S.W. 1891, p. 658. Zeehan.

Fisera, Wlk.

perplexata, Wlk. P.L.S.N.S.W. 1891, p. 659 (*belidearia*).

Stathmorrhopa, Meyr.

beggaria, Gn. P.L.S.N.S.W. 1891, p. 660. Hobart; Mt. Wellington; Bothwell; Launceston.

Smyriodes, Gn.

aplectaria, Gn. P.L.S.N.S.W. 1891, p. 667. Launceston.

carburaria, Gn. Tr. R.S.S.A. 1893, p. 164. Launceston.

Gastrina, Gn.

cristaria, Gn. P.L.S.N.S.W. 1891, p. 668. Launceston.

Mictodoca, Meyr.

toxeuta, Meyr. P.L.S.N.S.W. 1891, p. 661. Beaconsfield.

Conosara, Meyr.

**castaneata*, Meyr. P.L.S.N.S.W. 1891, p. 660. Hobart; Launceston.

Capusa, Wlk.

senilis, Wlk. Cat. Brit. Mus. XI., p. 621. Launceston.

Ciampa, Wlk.

arietaria, Gn. P.L.S.N.S.W. 1891, p. 663. Hobart; Launceston.

Chlenias, Gn.

umbraticaria, Gn. P.L.S.N.S.W. 1891, p. 664.

banksiaria, Le Guil. P.L.S.N.S.W. 1891, p. 664. Launceston.

zonæa, Meyr. P.L.S.N.S.W. 1891, p. 665. Hobart; Launceston.

seminigra, Rosen. P.L.S.N.S.W. 1891, p. 666. Hobart.

psolina, Turn. P.L.S.N.S.W. 1919, p. 401. Sheffield.

Stibaroma, Meyr.

melanotoxa, Meyr. P.L.S.N.S.W. 1891, p. 669.

**Ecpatites*, Turn.

**callipolia*, Turn. P.R.S. Tas. 1925. Rosebery.

Drymoptila, Meyr.

temenitis, Meyr. P.L.S.N.S.W. 1891, p. 670. Hobart; Mt. Wellington, 2,500 ft.

**Archephanes*, Turn.

**zalosema*, Turn. P.R.S. Tas. 1925. Mt. Wellington, 4,000 ft.; Lake Fenton, 3,500 ft.; Cradle Mt., 3,000 ft.

**Hypsitropha*, Turn.

**euschema*, Turn. P.R.S. Tas. 1925. Mt. Wellington, 2,500 ft.; Lake Fenton, 3,500 ft.; Cradle Mt., 3,000 ft.

**Neoteristis*, Meyr.

**paraphanes*, Meyr. P.L.S.N.S.W. 1891, p. 672. Deloraine.

**Dirce*, Prout.

**æsiodora*, Turn. Tr. R.S.S.A. 1922, p. 291. Cradle Mt., 3,000 ft.

**solaris*, Meyr. P.L.S.N.S.W. 1889, p. 1195. Mt. Wellington, 4,000 ft.

**lunaris*, Meyr. P.L.S.N.S.W. 1889, p. 1195. Mt. Wellington, 4,000 ft.

**oriplancta*, Turn. P.R.S. Tas. 1925. Lake Fenton, 3,500 ft.

ŒNOCHROMIDÆ.

Adeixis, Warr.

inostentata, Wlk. Cat. Brit. Mus. XXIII., p. 1012. Hobart; Zeehan; Strahan.

Dichromodes, Gn.

ainaria, Gn. P.L.S.N.S.W. 1889, p. 1170. Hobart; St. Helens; Zeehan; Strahan.

**diasemaria*, Gn. P.R.S. Tas. 1925. St. Helens; Cradle Mt., 3,000 ft.; Strahan.

euscia, Meyr. P.L.S.N.S.W. 1889, p. 1185. Zeehan; Strahan.

**trychnoptila*, Turn. Tr. R.S.S.A. 1906, p. 131. Zeehan.

consignata, Wlk. P.L.S.N.S.W. 1889, p. 1191. St. Helens.

stilbiata, Gn. P.L.S.N.S.W. 1889, p. 1192. Hobart; Lake Fenton, 3,500 ft.; Deloraine; Cradle Mt., 3,000 ft.; Rosebery; Zeehan; Strahan.

confluaria, Gn. P.L.S.N.S.W. 1889, p. 1193. Hobart; St. Helens; Launceston; Deloraine; Zeehan.

**phæostropha*, Turn. P.R.S. Tas. 1925. Beaconsfield; Rosebery; Strahan.

Nearcha, Meyr.

buffalaria, Gn. P.L.S.N.S.W. 1889, p. 1154.

subcelata, Wlk. P.L.S.N.S.W. 1889, p. 1157. Hobart.

curtaria, Gn. P.L.S.N.S.W. 1889, p. 1158. Hobart; Russell Falls; George Town; Beaconsfield; Ulverstone; Strahan.

Antasia, Warr.

flavicapitata, Gn. P.L.S.N.S.W. 1889, p. 1152. Hobart; St. Helens; Launceston; Strahan.

Zeuctophlebia, Warr.

squalidata, Wlk. Cat. Brit. Mus. XXVI., p. 1671. Launceston.

Taxeotis, Meyr.

inconcisata, Wlk. P.L.S.N.S.W. 1889, p. 1146 (*delogramma*). St. Helens; Deloraine; Prospect.

oraula, Meyr. P.L.S.N.S.W. 1889, p. 1143. Russell Falls; Beaconsfield; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Burnie; Rosebery; Strahan.

subvelaria, Wlk. P.L.S.N.S.W. 1889, p. 1150 (*isophanes*). Hobart; Prospect.

anthracopa, Meyr. P.L.S.N.S.W. 1889, p. 1145. Hobart; Deloraine.

Epidesmia, Westw.

hypenaria, Gn. P.L.S.N.S.W. 1889, p. 1163. Hobart; Mt. Wellington, 2,500 ft.; Russell Falls; Lake Fenton, 3,500 ft.; St. Helens; Launceston; Deloraine; Cradle Mt., 3,000 ft.

Monoctenia, Gn.

falernaria, Gn. P.L.S.N.S.W. 1889, p. 1208. Hobart.

Arhodia, Gn.

lasiocamparia, Gn. P.L.S.N.S.W. 1889, p. 1202. Hobart.

Hypographa, Gn.

phlegetonaria, Gn. P.L.S.N.S.W. 1889, p. 1212.

Onycodes, Gn.

traumataria, Gn. P.L.S.N.S.W. 1889, p. 1200. Hobart; Beaconsfield; Ulverstone; Rosebery; Strahan.

Circopetes, Prout.

obtusata, Wlk. P.L.S.N.S.W. 1889, p. 1207.

Oenochroma, Gn.

vetustaria, Wlk. P.L.S.N.S.W. 1889, p. 1207 (*digglesaria*). Bothwell.

NOTODONTIDÆ.

Cnethocampinæ.

Trichetra, Westw.

sparshalli, Curtis. P.L.S.N.S.W. 1922, p. 363. Hobart; Launceston.

Epicoma, Hb.

melanospila, Wlgrn. P.L.S.N.S.W. 1922, p. 365. Hobart; Launceston.

melanosticta, Don. P.L.S.N.S.W. 1922, p. 367. Hobart; Launceston.

tristis, Lewin. P.L.S.N.S.W. 1922, p. 367. Hobart; Beaconsfield.

Teara, Wlk.

**periblepta*, Turn. P.L.S.N.S.W. 1922, p. 372. Mt. Wellington; Lake Fenton, 3,500 ft.; Cradle Mt., 3,000 ft.

Oenosanda, Wlk.

boisduvalii, Newm. P.L.S.N.S.W. 1903, p. 58. Hobart; Launceston.

Notodontinæ.

Hyleora, Dbld.

inclyta, Wlk. P.L.S.N.S.W. 1903, p. 47.

Neola, Wlk.

semiaurata, Wlk. P.L.S.N.S.W. 1903, p. 49.

Sorama, Wlk.

bicolor, Wlk. P.L.S.N.S.W. 1903, p. 51. Launceston; Ulverstone.

Gallaba, Wlk.

eugraphes, Turn. P.L.S.N.S.W. 1922, p. 388. Lake Fenton, 3,500 ft.; Cradle Mt., 3,000 ft.; Zeehan; Strahan.

SPHINGIDÆ.

Hippotion, Hb.

celerio, Lin. Hobart; Launceston.

scrofa, Bdv. Hobart; Launceston.

NOCTUOIDEA.

ARCTIADÆ.

Hestiarcha, Meyr.

**atala*, Turn. P.R.S. Vic. 1922, p. 29. Mt. Wellington.

**Thermeola*, Hmps.

**tasmanica*, Hmps. Cat. Lep. Phal. II., p. 96. Hobart.

Scoliacma, Meyr.

bicolor, Bdv. Cat. Lep. Phal. II., p. 103. Tasman Peninsula; Launceston.

Phæophlebosia, Hmps.

furcifera, Wlk. P.L.S.N.S.W. 1886, p. 698. Hobart; Bothwell.

Apistosia, Hb.

chionora, Meyr. P.L.S.N.S.W. 1886, p. 702. Launceston.

Palæosia, Hmps.

bicosta, Wlk. P.L.S.N.S.W. 1886, p. 702. Hobart; Bothwell; Launceston; Beaconsfield; Wilmot; Rosebery.

Halone, Wlk.

sejuncta, Feld. P.L.S.N.S.W. 1886, p. 730. Launceston; Beaconsfield.

Caprimima, Hmps.

procrena, Meyr. P.L.S.N.S.W. 1886, p. 733. Russell Falls; Lake Fenton, 3,500 ft.; Deloraine; Wilmot; Moina, 2,000 ft.; Rosebery; Zeehan; Strahan.

**sicciodes*, Hmps. P.R.S. Tas. 1925. Mt. Wellington, 2,500 ft.; Russell Falls; Launceston; Moina, 2,000 ft.; Zeehan; Strahan.

Asura, Wlk.

lydia, Don. P.L.S.N.S.W. 1886, p. 747. Launceston.

cervicalis, Wlk. P.L.S.N.S.W. 1886, p. 748. Ross; Swansea; Launceston; Beaconsfield; George Town.

**habrotis*, Meyr. P.L.S.N.S.W. 1886, p. 748.

Thallarcha, Meyr.

albicollis, Feld. P.L.S.N.S.W. 1886, p. 737. Hobart; Triabunna; Bothwell.

**isophragma*, Meyr. P.L.S.N.S.W. 1886, p. 296. Bothwell; St. Helens; Launceston.

**epiostola*, Turn. P.R.S. Tas. 1925. Launceston.

jocularis, Rosen. P.L.S.N.S.W. 1886, p. 741. Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

**Nesotropha*, Turn.

**pygmæodes*, Turn. P.R.S. Tas. 1925. Cradle Mt., 3,000 ft.

Philenora, Rosen.

undulosa, Wlk. Tr. R.S.S.A. 1892, p. 149 (*lyelliana*).

Castulo, Wlk.

plagiata, Wlk. P.L.S.N.S.W. 1886, p. 715 (*struthias*). Dunalley.

doubledayi, Newm. P.L.S.N.S.W. 1886, p. 716 (*rubricosta*). Hobart; Launceston.

Ardices, Wlk.

curvata, Don. P.L.S.N.S.W. 1886, p. 752 (*fuscinula*). Geeveston; George Town.

**vigens*, Butl. P. Zool. Soc. 1878, p. 383. George Town.

glatignyi, Le Guil. P.L.S.N.S.W. 1886, p. 754 (*fulvohirta*). Hobart; Tasman Peninsula.

Diacrisia, Hb.

canescens, Butl. P.L.S.N.S.W. 1886, p. 755 (*obliqua*). Launceston; Latrobe.

Amsacta, Wlk.

marginata, Don. P.L.S.N.S.W. 1886, p. 755. Beaconsfield.

Phaos, Wlk.

**interfixa*, Wlk. P.R.S. Tas. 1925. Mt. Wellington; Cradle Mt., 3,000 ft.

**acmena*, Turn. P.R.S. Tas. 1925. Bothwell; Launceston.

Utetheisa, Hb.

pulchella, Lin. P.L.S.N.S.W. 1886, p. 758. Launceston; Strahan.

NOLIDÆ.

Celama, Wlk.

paromœa, Meyr. P.L.S.N.S.W. 1886, p. 721. Wilmot; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

albalis, Wlk. P.L.S.N.S.W. 1886, p. 721 (*vetustella*). Hobart; St. Helens; Launceston; Zeehan.

biguttalis, Wlk. P.L.S.N.S.W. 1886, p. 719 (*trigonota*). Beaconsfield; Rosebery; Strahan.

**tholera*, Turn. P.R.S. Tas. 1925. Wilmot.

Nola, Leach.

semograpta, Meyr. P.L.S.N.S.W. 1886, p. 720. Bothwell; Deloraine.

parallacta, Meyr. P.L.S.N.S.W. 1886, p. 723. Hobart; Cradle Mt., 3,000 ft.; Strahan.

cycota, Meyr. P.L.S.N.S.W. 1886, p. 723. Zeehan; Strahan.

aulacota, Meyr. P.L.S.N.S.W. 1886, p. 722. Mt. Wellington; Launceston; Deloraine; Strahan.

**macrorrhyncha*, Turn. P.R.S. Tas. 1925. Hobart.

Rœsclia, Hb.

lugens, Wlk. Cat. Lep. Phal. II., p. 72. Hobart; Bothwell, Launceston; Beaconsfield.

NOCTUIDÆ.

Agaristinæ.

Eutrichopidia, Hmps.

latina, Don. Cat. Lep. Phal. III., p. 554. Hobart; Launceston.

Phalænoides, Lewin.

glycinæ, Lewin. Cat. Lep. Phal. III., p. 558. Launceston.

tristifica, Hb. Cat. Lep. Phal. III., p. 559. Mt. Wellington; Dunalley; Russell Falls; Lymington; Launceston; Deloraine; Cradle Mt.; Burnie.

Hecatesia, Bdv.

fenestrata, Bdv. Cat. Lep. Phal. III., p. 594. Cygnet; Tasman Peninsula; Beaconsfield; Strahan.

Radinocera, Hmps.

**placodes*, Low. Tr. R.S.S.A. 1903, p. 30. Hobart.

Agaristodes, Hmps.

feisthameli, H-Sch. Cat. Lep. Phal. IX., p. 456.

Apina, Wlk.

callista, Wlk. Cat. Lep. Phal. IX., p. 449. Hobart.

Agrotinæ.

Heliothis, Ochs.

obsoleta, Fab. Cat. Lep. Phal. IV., p. 657. Launceston; Wynyard.

Euxoa, Hb.

radians, Gn. Cat. Lep. Phal. IV., p. 164. Hobart; Launceston.

porphyricollis, Gn. Cat. Lep. Phal. IV., p. 165. Hobart; Cygnet; Ross; Launceston.

repanda, Wlk. Cat. Lep. Phal. IV., p. 163. Launceston.

Agrotis, Ochs.

infusa, Bdv. Cat. Lep. Phal. IV., p. 164. Hobart; Geeveston; Launceston.

Graphiphora, Ochs.

compta, Wlk. Cat. Lep. Phal. IV., p. 409. Hobart; Launceston.

Proteuxoa, Hmps.

amaurodes, Low. P.L.S.N.S.W. 1901, p. 642. Beaconsfield.

Melanchrinæ.

Sideridis, Hb.

**eboriosa*, Gn. Cat. Lep. Phal. V., p. 479. Hobart; Launceston.

**costalis*, Wlk. Cat. Lep. Phal. V., p. 479.

obusta, Gn. Cat. Lep. Phal. V., p. 479.

exarans, Luc. Tr. R.S.S.A. 1908, p. 56 (*orthomita*). Cradle Mt.

unipuncta, Haw. Cat. Lep. Phal. V., p. 547. Launceston.

ewingii, Westw. Cat. Lep. Phal. V., p. 386. Hobart; Launceston.

Dasygaster, Gn.

ligniplena, Wlk. Cat. Lep. Phal. V., p. 474. Hobart; Mt. Wellington; Wilmot; Strahan.

nephelistis, Hmps. Cat. Lep. Phal. V., p. 475.

hollandiæ, Gn. Cat. Lep. Phal. V., p. 476. Hobart; Bothwell; Launceston; Cradle Mt., 3,000 ft.; Zeehan.

**epundoides*, Gn. Cat. Lep. Phal. V., p. 477. Hobart; Mt. Wellington; Cradle Mt.

**pammacha*, Turn. P.R.S. Vic. 1923, p. 33. Lake Fenton, 3,500 ft.; Cradle Mt., 3,000 ft.

Cuculllianæ.

Neumichtis, Hmps.

trijuncta, Wlk. Cat. Lep. Phal. VI., p. 298. Launceston.

Eumichtis, Hb.

sepultrix, Gn. Cat. Lep. Phal. VI., p. 333. Hobart; Mt. Wellington; Brighton; St. Mary's; Launceston; Cradle Mt.; Strahan.

saliaris, Gn. Cat. Lep. Phal. VI., p. 342. Hobart; Mt. Wellington, 2,500 ft.; Brighton; Bothwell; Wilmot; Burnie; Strahan.

Acronyctinæ.

Cosmodes, Gn.

elegans, Don. Cat. Lep. Phal. VIII., p. 17. Launceston.

Euplexia, Stph.

**iorrhoa*, Meyr. Tr. Ent. Soc. 1902, p. 27. Hobart; Mt. Wellington; Lake Fenton, 3,500 ft.; Cradle Mt., 3,000 ft.

bryochlora, Meyr. Tr. Ent. Soc. 1897, p. 371.

**signata*, Low. Tr. R.S.S.A. 1905, p. 173. Hobart; Launceston.

**calliphara*, Turn. P.R.S. Tas. 1925. Bothwell; Moina, 2,000 ft.

nigerrima, Gn. Noct. I., p. 200. Hobart; Launceston.

Bathytricha, Turn.
truncata, Wlk. Cat. Lep. Phal. IX., p. 267.

Peripyra, Hmps.
sanguinipuncta, Gn. Cat. Lep. Phal. VII., p. 25. Hobart; Bothwell; Launceston; Rosebery.

Prometopus, Gn.
inassueta, Gn. P.L.S.N.S.W. 1902, p. 86 (*chromoneura*). Hobart; Launceston; Ulverstone.

Omphaletis, Hmps.
melodora, Low. Cat. Lep. Phal. VIII., p. 379. Launceston.

Caradrina, Ochs.
exundans, Gn. Cat. Lep. Phal. VIII., p. 377. Hobart; Tasman Peninsula.
tortisigna, Wlk. Cat. Lep. Phal. VIII., p. 390. Hobart.
paratorna, Low. P.L.S.N.S.W. 1902, p. 655. Launceston; Beaconsfield; Ulverstone.
hydræcioides, Gn. P.L.S.N.S.W. VIII., p. 395.
marginalis, Wlk. Cat. Lep. Phal. VIII., p. 396. Hobart.
bistrigula, Wlk. Cat. Lep. Phal. VIII., p. 399. Hobart.
capularis, Gn. Cat. Lep. Phal. VIII., p. 400. Hobart; Beaconsfield.
atra, Gn. Cat. Lep. Phal. VIII., p. 401. Hobart; Launceston.
atrisquamata, Low. P.L.S.N.S.W. 1902, p. 653. Hobart.
interferens, Wlk. Cat. Lep. Phal. VIII., p. 406. Hobart.
flexirena, Wlk. Cat. Lep. Phal. VIII., p. 406. Hobart.

Plusianæ.

Plusia, Ochs.
argentifera, Gn. Cat. Lep. Phal. XIII., p. 489. Hobart; Launceston; Ulverstone.

Noctuinæ.

Corrha, Wlk.
**difficilis*, Wlk. Cat. Brit. Mus. XIII., p. 1090.

Praxis, Gn.
edwardsi, Gn. Noct. III., p. 29. Launceston; Ulverstone.

porphyretica, Gn. Noct. III., p. 29.

Diatenes, Gn.
gerula, Gn. Noct. II., p. 443.

Dasypodia, Gn.
selenophora, Gn. Noct. III., p. 175. Launceston.

Alapadna, Turn.
pauropis, Turn. P.L.S.N.S.W. 1902, p. 106. Russell Falls; Launceston; Burnie.

Rhapsa, Wlk.
suscitalis, Wlk. Cat. Brit. Mus. XVI., p. 83. Russell Falls.

Artigisa, Wlk.
**lignicolaria*, Wlk. Cat. Brit. Mus. XXXV., p. 1579. Hobart; Russell Falls; Bothwell; Launceston; Wilmot; Ulverstone.
**melanephele*, Hmps. *ined?*

Sandava, Wlk.
xylistis, Swin. Tr. E.S. 1902, p. 37. Launceston.

Rhodina, Gn.
falculalis, Gn. Tr. R.S.S.A. 1897, p. 52 (*mesochra*). Russell Falls; Rosebery; Zeehan; Strahan.

Liodes, Gn.
neurogramma, Turn. Tr. R.S.S.A. 1906, p. 123. George Town.

Meyrickiella, Berg.
ruptella, Wlk. Cat. Brit. Mus. XXVII., p. 173. Hobart; Beaconsfield.

Hypeninæ.

Tipasa, Wlk.
asthenopa, Meyr. Tr. Ent. Soc. 1902, p. 40. Launceston; Burnie; Strahan.

LYMANTRIADÆ.

Porthesia, Stph.
melanosoma, Butl. P.L.S.N.S.W. 1920, p. 478. Hobart; Mt. Wellington; Launceston; George Town.

Acyphas, Wlk.
leucomelas, Wlk. P.L.S.N.S.W. 1920, p. 481. Hobart; Bothwell; Swansea; Launceston; Beaconsfield; George Town; Latrobe.
**fulviceps*, Wlk. P.L.S.N.S.W. 1920, p. 482. Hobart.

Euproctis, Hb.
marginalis, Wlk. P.L.S.N.S.W. 1920, p. 487.

Orgyia, Ochs.
anartoides, Wlk. P.L.S.N.S.W. 1920, p. 493. Hobart; Bothwell; Launceston.

HYPSIDÆ.

Nyctemera, Hb.
amica, White. P.L.S.N.S.W. 1886, p. 760. Hobart; Triabunna; Launceston; Beaconsfield.

ANTHELIDÆ.

Pterolocera, Wlk.
amplicornis, Wlk. P.L.S.N.S.W. 1921, p. 165. Hobart; Launceston; Cradle Mt., 3,000 ft.; Latrobe; Strahan.

Nataxa, Wlk.
flavescens, Wlk. P.L.S.N.S.W. 1921, p. 166.

Anthela, Wlk.
ferruginosa, Wlk. P.L.S.N.S.W. 1921, p. 171. Hobart; Launceston.
**pyrrhobaphes*, Turn. P.R.S. Tas. 1925. Zeehan.
**phæozona*, Turn. P.R.S. Tas. 1925. Bothwell.
acuta, Wlk. P.L.S.N.S.W. 1921, p. 176. Hobart; Swansea; Launceston; Sheffield; Ulverstone; Burnie.
**cnecias*, Turn. P.L.S.N.S.W. 1921, p. 178. Launceston.
ocellata, Wlk. P.L.S.N.S.W. 1921, p. 178. Hobart; Launceston.
addita, Wlk. P.L.S.N.S.W. 1921, p. 183. Hobart; Ulverstone.
repleta, Wlk. P.L.S.N.S.W. 1921, p. 185. Bothwell; Launceston; Sheffield.
connexa, Wlk. P.L.S.N.S.W. 1921, p. 186. Launceston; Strahan.
nicothoë, Bdv. P.L.S.N.S.W. 1921, p. 186. Hobart; Launceston.

LASIOCAMPOIDEA.

LASIOCAMPIDÆ.

Pinara, Wlk.
cana, Wlk. P.L.S.N.S.W. 1924, p. 404. Launceston.
obliqua, Wlk. P.L.S.N.S.W. 1924, p. 404. Launceston.

Crexa, Wlk.

punctigera, Wlk. P.L.S.N.S.W. 1924, p. 406. Hobart; Geeveston; Launceston; Ulverstone.

vetusta, Wlk. P.L.S.N.S.W. 1924, p. 411. Launceston.

Porela, Wlk.

**subfasciata*, Wlk. P.L.S.N.S.W. 1924, p. 413. Beaconsfield; George Town; Ulverstone.

albifinis, Wlk. P.L.S.N.S.W. 1924, p. 415. Hobart; Launceston.

**contermina*, Wlk. P.L.S.N.S.W. 1924, p. 415.

Entometa, Wlk.

marginata, Wlk. P.L.S.N.S.W. 1924, p. 418.

fervens, Wlk. P.L.S.N.S.W. 1924, p. 418. Launceston.

apicalis, Wlk. P.L.S.N.S.W. 1924, p. 419. Launceston.

Digglesia, Turn.

rufescens, Wlk. P.L.S.N.S.W. 1924, p. 423. Hobart; Mt. Wellington, 2,500 ft.

**nana*, Wlk. P.L.S.N.S.W. 1924, p. 424. Launceston.

australasiæ, Fab. P.L.S.N.S.W. 1924, p. 424. Hobart; Bothwell; Launceston; Ulverstone; Strahan.

Opsirhina, Wlk.

albigutta, Wlk. P.L.S.N.S.W. 1924, p. 425. Hobart; Launceston.

Perna, Wlk.

exposita, Lewin. P.L.S.N.S.W. 1924, p. 427. Hobart.

PSYCHOIDEA.

LIMACODIDÆ.

Doratifera, Westw.

pinguis, Wlk. Cat. Brit. Mus. V., p. 1119. Hobart; Triabunna; Launceston.

ZYGÆNIDÆ.

Hestiochora, Meyr.

tricolor, Wlk. P.L.S.N.S.W. 1886, p. 789. Hobart; Triabunna; Launceston; Deloraine.

Pollanisus, Wlk.

cyanotus, Meyr. P.L.S.N.S.W. 1886, p. 793. Hobart; Rosebery; Strahan.

subdolosus, Wlk. P.L.S.N.S.W. 1886, p. 793. Launceston; Beaconsfield.

viridipulverulentus, Guer. P.L.S.N.S.W. 1886, p. 794. Hobart; Tasman Peninsula; Launceston; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Zeehan; Strahan.

calliceros, Turn. P.R.S. Tas. 1925. Moina, 2,000 ft.

Procris, Fab.

dolens, Wlk. P.L.S.N.S.W. 1886, p. 791. Hobart; Huon River; Campbell Town; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Zeehan.

PSYCHIDÆ.

Clania, Wlk.

dewitzi, Heyl. Tr. R.S.S.A. 1907, p. 196. Launceston.

ignobilis, Wlk. Prod. Zool. Vict., Pl. 40, f. 7-10. Triabunna.

tenuis, Rosèn. Tr. R.S.S.A. 1907, p. 197. Launceston.

PYRALOIDEA.

PHYCITIDÆ.

Homœosoma, Curtis.

fornacella, Meyr. P.L.S.N.S.W. 1880, p. 219. St. Helens.

farinaria, Turn. P.R.S.Q. 1903, p. 126. Strahan.

Unadilla, Hulst.

distichella, Meyr. P.L.S.N.S.W. 1878, p. 215. Hobart; Launceston.

Hyphantidium, Scott.

sericarium, Scott. P.L.S.N.S.W. 1880, p. 231 (*microdoxa*). Launceston.

Epicrocis, Zel.

sublignalis, Wlk. P.L.S.N.S.W. 1878, p. 202 (*strigiferella*). Hobart.

Sclerobia, Rag.

tritalis, Wlk. P.L.S.N.S.W. 1878, p. 207 (*vulgatella*). Hobart; Swansea; Bothwell; Beaconsfield.

Etiella, Zel.

behrii, Zel. P.L.S.N.S.W. 1878, p. 205. Strahan.

GALLERIADÆ.

Meyrickia, Rag.

latro, Zel. P.L.S.N.S.W. 1879, p. 238. Freycinet Peninsula.

Heteromicta, Meyr.
pachytera, Meyr. P.L.S.N.S.W. 1879, p. 237. Hobart.

CRAMBIDÆ.

Ptochostòla, Meyr.
microphæella, Wlk. P.L.S.N.S.W. 1878, p. 190 (*dimidiellus*). Hobart; Tunbridge; Launceston; Beaconsfield.

Crambus, Fab.
cuneiferellus, Wlk. P.L.S.N.S.W. 1878, p. 189. Beaconsfield.

**Notocrambus*, Turn.
**holomelas*, Turn. P.R.S. Vic. 1922, p. 45. Cradle Mt., 3,000 ft.

Thinasotia, Hb.
pentadactyla, Zel. Cat. Brit. Mus. XXXV., p. 1765 (*claviferella*). Hobart; Bothwell; Launceston.

Chilo, Zinck.
lativittalis, Wlk. P.L.S.N.S.W. 1878, p. 183. St. Helens; Deloraine; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Rosebery; Strahan.

Sedenia, Gn.
rupalis, Gn. Delt. & Pyr., p. 250. Hobart; Launceston; Latrobe; Strahan.
cervalis, Gn. Delt. & Pyr., p. 250. Hobart; Launceston.

Diptychophora, Zel.
ochracealis, Wlk. P.L.S.N.S.W. 1878, p. 198. Hobart: Mt. Wellington, 2,500 ft.

Talis, Gn.
bivitella, Don. P.L.S.N.S.W. 1878, p. 185 (*trivittatus*). Hobart; Launceston.
pleniferella, Wlk. P.L.S.N.S.W. 1878, p. 187. Hobart; Deloraine.
**impletella*, Wlk. P.L.S.N.S.W. 1879, p. 210. Hobart; Bothwell.
**perlatalis*, Wlk. P.L.S.N.S.W. 1879, p. 213. Hobart; Launceston.
relatalis, Wlk. P.L.S.N.S.W. 1878, p. 191. Hobart; Russell Falls; Launceston; Beaconsfield; Wilmot; Burnie; Rosebery; Zeehan; Strahan.
panselenella, Meyr. P.L.S.N.S.W. 1882, p. 165. Hobart.

opulentella, Zel. P.L.S.N.S.W. 1878, p. 192. Hobart.

orthotypa, Turn. P.R.S.Q. 1903, p. 176. Lake Fenton, 3,500 ft.; Moina, 2,000 ft.; Rosebery; Strahan.

grammella, Zel. P.L.S.N.S.W. 1878, p. 194 (*enneagrammos*). Hobart; Mt. Wellington, 2,500 ft.; Bothwell; Beaconsfield; Wilmot; Moina, 2,000 ft.; Burnie; Strahan.

invalidella, Meyr. P.L.S.N.S.W. 1878, p. 193. Hobart.

acontophora, Meyr. P.L.S.N.S.W. 1882, p. 1671. Hobart; Bothwell.

pedionoma, Meyr. Tr. E.S. 1885, p. 453. Hobart; Launceston.

megalarcha, Meyr. Tr. E.S. 1885, p. 454. Lake Fenton, 3,500 ft.; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

**gelastis*, Meyr. Tr. E.S. 1887, p. 250. Campbell Town.

enchias, Meyr. Tr. E.S. 1897, p. 380. Hobart.

SCHŒNOBIADÆ.

Scirpophaga. Treit.

patulella, Wlk. P.L.S.N.S.W. 1882, p. 161 (*exsanguis*). Hobart; Russell Falls; Launceston; Beaconsfield; George Town; Deloraine; Wilmot; Rosebery; Zeehan; Strahan.

PYRALIDÆ.

Persicoptera, Meyr.

pulchrinalis, Gn. Delt. & Pyr., p. 220.

Endotricha, Zel.

pyrosalis, Gn. Delt. & Pyr., p. 219. Hobart; Launceston.

docilis, Wlk. Tr. E.S. 1884, p. 79 (*æthopa*). Beaconsfield.

Oenogenes, Meyr.

fugalis, Feld. Tr. E.S. 1884, p. 75. Hobart; Launceston; Deloraine.

Gauna, Wlk.

ægalis, Wlk. Tr. E.S. 1884, p. 74.

Diplopseustis, Meyr.

perieresalis, Wlk. Tr. E.S. 1884, p. 285 (*minima*). Rosebery; Zeehan.

Aglossa, Latr.
pinguinalis, Lin. Brit. Lep., p. 428. Hobart. (*Introduced.*)

Spectatrota, Warr.
fimbrialis, Warr. Ann. Mag. Nat. Hist. (6) VII., p. 427. Hobart.

Catamola, Meyr.
**tholoëssa*, Turn. P.R.S. Tas. 1925. Hobart.
funerea, Wlk. Tr. E.S. 1884, p. 65.

Macalla, Wlk.
recurvalis, Wlk. Tr. E.S. 1887, p. 189. Hobart; Launceston.
**marmorea*, Warr. P.R.S.Q. 1903, p. 198 (*crypserythra*). Hobart; Cygnet; Zeehan.
ebenina, Turn. P.R.S.Q. 1903, p. 197. Ross.

Epipaschia, Clem.
**habitalis*, Gn. Delt. & Pyr., p. 125.
costigeralis, Wlk. Tr. E.S. 1885, p. 439. Hobart; Launceston.
**amauropis*, Turn. P.R.S. Tas. 1925. Strahan.

PYRAUSTIDÆ.

Hydreuretis, Meyr.
oxygramma, Turn. Tr. R.S.S.A. 1908, p. 86. Bothwell.

Nymphula, Schrank.
nitens, Butl. Tr. N.Z. Inst. 1884, p. 122. Hobart; Swansea.
oculalis, Hmps. Tr. E.S. 1897, p. 160. Hobart.

Musotima, Meyr.
ochropteralis, Gn. Delt. & Pyr., p. 230. Launceston.
nitidalis, Wlk. Cat. Brit. Mus. XXXIV., p. 1317. Rosebery; Zeehan; Strahan.
acrias, Meyr. Tr. E.S. 1884, p. 289. Deloraine; Rosebery; Strahan.
stictochroa, Turn. P.R.S.Q. 1915, p. 37. Mt. Wellington, 2,500 ft.; Russell Falls.

Voliba, Wlk.
scoparialis, Wlk. Tr. E.S. 1885, p. 449. Hobart.

Nacoleia, Wlk.
rhœonalis, Wlk. Tr. E.S. 1884, p. 319 (*murcalis*). Launceston; Deloraine.

Metasia, Gn.

liophæa, Meyr. Tr. E.S. 1887, p. 241. Mt. Wellington, 2,500 ft.; Launceston.

hemicirca, Meyr. Tr. E.S. 1887, p. 241. Launceston.

capnochroa, Meyr. Tr. E.S. 1884, p. 338. Hobart; Mt. Wellington; Launceston; Beaconsfield.

homophæa, Meyr. Tr. E.S. 1885, p. 449. Hobart; Deloraine.

Pyrausta, Schrank.

hyalistis, Low. Tr. R.S.S.A. 1908, p. 100 (*diplosticta*). Mt. Wellington, 2,500 ft.; Russell Falls; Launceston; Cradle Mt., 3,000 ft.; Burnie.

Mecyna, Gn.

ornithopteralis, Gn. Delt. & Pyr., p. 411. Hobart; Launceston.

Heliothela, Gn.

persumptana, Wlk. Tr. E.S. 1884, p. 344.

floricola, Turn. P.R.S.Q. 1912, p. 159. Cradle Mt., 3,000 ft.

Eclipsiodes, Meyr.

drosera, Meyr. Tr. E.S. 1897, p. 245.

Scoparia, Haw.

meyrickii, Butl. Tr. N.Z. Inst. 1884, p. 108. Hobart.

philonephes, Meyr. Tr. N.Z. Inst. 1884, p. 110. Rosebery; Strahan.

favilliferella, Wlk. Tr. N.Z. Inst. 1884, p. 111 (*encausta*). Hobart; Mt. Wellington, 2,500 ft.; Lake Fenton, 3,500 ft.; Bothwell; Ross; Wilmot; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.

anthracias, Meyr. Tr. N.Z. Inst. 1884, p. 74. Hobart; Russell Falls; Launceston; Wilmot; Burnie; Rosebery.

axiolecta, Turn. P.R.S. Vic. 1922, p. 53. Cradle Mt., 3,000 ft.

exhibitalis, Wlk. Tr. N.Z. Inst. 1884, p. 77. Hobart; Russell Falls; Bothwell; Strahan.

syntaracta, Meyr. Tr. N.Z. Inst. 1884, p. 77. Hobart; Mt. Wellington, 1-3,000 ft.; Russell Falls; Launceston; Wilmot; Burnie; Rosebery; Zeehan.

*synapta, Meyr. Tr. N.Z. Inst. 1884, p. 78. Mt. Wellington, 2,500-3,000 ft.; Lake Fenton, 3,500 ft.

*perierga, Meyr. Tr. N.Z. Inst. 1884, p. 80. Mt. Wellington, 3-4,000 ft.

*gomphota, Meyr. Tr. N.Z. Inst. 1884, p. 80. Mr. Wellington, 2,000 ft.

*anaplecta, Meyr. Tr. N.Z. Inst. 1884, p. 89. Mt. Wellington, 3,000 ft.; Cradle Mt., 3,000 ft.

spelæa, Meyr. Tr. N.Z. Inst. 1884, p. 89. Hobart; Russell Falls; Launceston; Deloraine; Wilmot.

*acropola, Meyr. Tr. N.Z. Inst. 1884, p. 101. Mt. Wellington, 4,000 ft.

cleodoralis, Wlk. Tr. N.Z. Inst. 1884, p. 101. Hobart; Mt. Wellington, 2,500-3,000 ft.; Lake Fenton, 3,500 ft.; Bothwell; Launceston; Deloraine; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Rosebery; Zeehan; Strahan.

oxygona, Meyr. Tr. E.S. 1897, p. 381. Hobart; Rosebery.

plagiotis, Meyr. Tr. E.S. 1887, p. 247. Hobart; Bothwell; Campbell Town; Wilmot; Moina, 2,000 ft.; Rosebery; Zeehan; Strahan.

PTEROPHOROIDEA.

PTEROPHORIDÆ.

Platyptilia, Hb.

emissalis, Wlk. Cat. Brit. Mus. XXX., p. 930. Wilmot; Cradle Mt., 3,000 ft.; Moina, 2,000 ft.; Burnie.

Stenoptilia, Hb.

phæonephes, Meyr. Tr. E.S. 1886, p. 19. Mt. Wellington, 2,500 ft.; Wilmot; Moina, 2,000 ft.; Cradle Mt., 3,000 ft.; Rosebery.

zophodactyla, Dup. Cat. Brit. Mus. XXX., p. 944 (*canalis*). Cradle Mt., 3,000 ft.; Strahan.

NOTES ON THE JOURNAL OF CAPTAIN CHARLES O'HARA BOOTH.

Sometime Commandant of Port Arthur.

By

R. W. GIBLIN, F.R.G.S., F.R.C.I.

Plate XI.

(Read 9th November, 1925.)

(Communicated by Sir Alfred Ashbolt, Kt.)

A document of considerable importance has recently been presented to the Royal Society of Tasmania under circumstances which are not without a touch of romance. Perhaps it would be more correct to say that a copy of part of a very human document has been so made available for the use of the Society. The original manuscript is the private journal kept by Captain Charles O'Hara Booth, for some years Commandant of the Penal Establishment at Port Arthur, and afterwards Superintendent of the Queen's Orphan School, male and female, at New Town. (1)

Charles Booth was born on the 30th August, 1800, at Basingstoke, Hampshire, where his parents occupied a house of some importance in that neighbourhood. They were of that class in England, of good family, which presented its sons freely to the public services of the country, and was able in many cases to advance the interests of the children by the system of purchase in use in the Army of that day. An elder brother was in the Navy when Charles Booth began his military career, while a younger brother also entered that Service, and died as recently as 1898 with the rank of Admiral.

The journal was begun on the 5th of July, 1815—Waterloo year—when the youth set out for India in the hope of obtaining a commission in the Honourable East India Company's service. Things moved slowly in those days; the ship did not arrive at Calcutta till the 11th of January, 1816, and no Ensigncy was forthcoming till the following September, when he was appointed to the 53rd Regiment. Then followed some years of service, but a rude shock came in 1819,

[(1) Booth was appointed Superintendent of the Queen's Orphan School at New Town in 1844; *vide Gazette* of 15/3/1844. His appointment was confirmed by the Home authorities in *Gazette* of 24/1/1845. Booth remained in charge until his death, which occurred on 11/8/1851.—Ed.]

Figure 1.
Mrs. Charles O'Hara Booth.

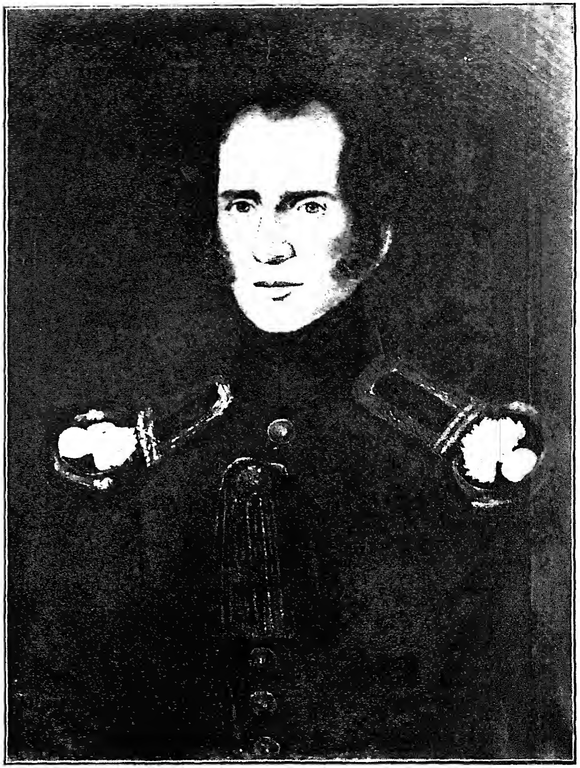


Figure 2.
Capt. Charles O'Hara Booth.

when, with others, he was reduced to half-pay and compelled "in low spirits" to return to England. On the way thither, this also being a six months' voyage (April to October), a call was made at St. Helena, the inevitable visit paid to Longwood, and a reputed view of the fallen Emperor obtained. In December of that year his brother James, home on two days' leave from his ship, mentioned that a Second Lieutenant of the 21st Fusiliers wished to sell out. This was too good a chance to be missed, and a month later Charles Booth found himself an officer by purchase in that regiment. In 1821 he was stationed at Demerara, in British Guiana. It is uncertain how long he stayed there.

Now, an interesting feature of this journal is that the writer used the right-hand page only when making his chronological entries. When he came to the end of the book, which was thus only half filled in, he turned it round and wrote on the blank half of each opening, which had, of course, now become the right-hand page. For a certain reason this has had rather a disastrous result from a Tasmanian point of view. At some time someone has torn out from the book a number of pages. There is no apparent reason for this action; it may have been that the period so dealt with, April to December, 1826, covered a period that it gave little pleasure to recall. Be that as it may, the elimination of those pages had as a consequence a serious gap in the record of a later time, and the hiatus created happened to be from March, 1835, two years after Captain Booth became Commandant of Port Arthur, to January, 1836.

On their return from the West Indies the 21st Fusiliers were stationed at Windsor. On the 20th June, 1827, Booth writes, "Went to Ascot. His Majesty's entry to the course "one of the finest sights I ever witnessed—loudly cheered— "preceded by the Prickers—women lovely—and considerable "shew—should have regretted greatly missing the proceed- "ings." In 1828 Bath was the headquarters, and later in that year Fermoy in Ireland. It took several days' marching to reach the latter town from Waterford. One of those marches, a long and dreary one, caused the young Lieutenant to become irritable; "Damn the fellow," is the record in the journal, "damn the fellow who invented Bearskin caps—par- "ticularly in windy weather."

The regiment was in Mullingar in 1829 and Kilkenny in 1830. On the 16th of September of the latter year came

"the pleasing intelligence of Promotion by Purchase, thanks "to good fortune, a generous parent, and a dear sister. Paid "200 above regulation."

In 1831 the regiment was transferred to the Midlands. On its march thither from Liverpool Booth's detachment stayed for some days at Warrington, in Lancashire. The diary record of the 20th of October, 1831, is noteworthy. "After parade a party of us went on the railroad as far as "Newton by the 'Mary' steam coach, where it meets the "great Manchester train. At times we went a ¼ of a mile "in 23 seconds. Waited to see the Manchester train, which is "perfectly astonishing, and then returned." The excursion thus described took place only six years after the first public railroad in England was opened, between Stockton and Darlington. The seed sown that day in the writer's mind was to bear fruit in a humble way within another six years in a remote corner of the Empire. It is reasonable to suppose that the tramway between Long Bay and Norfolk Bay, (2) projected and begun by the Commandant in 1836, owed its origin to the experience gained in Lancashire.

A shock for the Fusiliers came in December, 1831, when they heard that beyond doubt New South Wales was to be their next station. Rumour was not far astray on this occasion. In July, 1832, Captain Booth was at home on two months' leave, before sailing for the Antipodes. An interesting entry is that of the 27th of that month: "Went over to Odiham to "see the arrangements of the Dinner to the Poor in Com-"memoration of the Passing of the 'Reform Bill'—went off "very well and arranged admirably."

On the 15th of September, 1832, Captain Booth, with his detachment, consisting of one Lieutenant, one Sergeant, and 28 men, left Deptford in the *Gloriana* bound for Hobart. Calling at Spithead they took convicts on board, but it was not till the 16th of October that a real start was made. The Lieutenant had to be left behind, being too ill for the journey. The ship made a good voyage, making her landfall at Port Davey on the 31st of January, 1833, anchoring that night opposite Green Island in D'Entrecasteaux Channel, and arriving at Hobart on the following afternoon.

The chief value of the journal as a Tasmanian historical document now comes into view. Booth's comments on pass-

[(2) Although all the timber, rails, etc., have decayed, the course of this railway can be traced plainly at the present day. The remains of the earthworks can be seen at many places, close to the road from Taranna to Long Bay—the latter settlement being now known as Oakwood, whilst the township at Port Arthur is known as Carnarvon.—Ed.]

ing events are short and to the point, nevertheless they will attract attention as affording a detail here and there of ways of life and of opinion about men in those days. His first remarks on landing are: "Waited on His Excel-"lency, the Lieut.-Governor, Col. Arthur. Strolled about the "town, a place that evidently will be before long of consider-"able size and consequence. Went off again to the ship, the "orders being very strict here; find that we shall not be "landed for several days—no Corps but the 63rd in this "Command at present—several good posts still kept up here "—but the golden days have fled."

However, Booth's luck was fairly good, for within a month after his arrival the Governor appointed him Commandant at Port Arthur, and he entered on a little kingdom which he made all his own, as his journal shows. While waiting for the brig that was to take him and his junior, Macgregor, to the penal establishment, there were several functions and social events for the officers. On the 28th of February a field day was arranged in honour of Her Majesty's Birthday. A déjeuné at Government House surprised him: "Agreeably astounded," wrote the impressionable Booth, who was never able to resist a pretty face, "at the dis-play of the "Fair—a very nice party—but dispersed rather early." Arthur's parties generally came to an end too soon for this sociable soldier man. Constantly this trait, this admiration for the fair sex, peeps out in the journal (I have said that this is a human document), but it was not allowed to interfere with duty.

That Booth was satisfied with his new post is shown by his entry on the 16th of March, after his arrival at the Settlement: "Took over the command—quite pleased with "my charge," and on the following day he wrote: "St. "Patrick's Day—Lowes and Detachment came in from Mac-"gregor's post (at Eagle Hawk Neck), all dined with me, "and embarked, leaving me in Command of a very snug "(though responsible) post."

In that spirit Captain Booth took over charge and entered upon those heavy duties which were to try all his powers and to undermine his constitution before he relinquished his command eleven years later. Port Arthur was only in its third year as a Settlement when he first went there, and an enormous amount of constructive work still remained to be carried out to bring it to that state of polish and perfection as an ideal establishment for the punishment and correction of offenders that he so strongly desired and

aimed at. There is one thing that this newly appointed official must have made up his mind about, without mental reservations of any kind. He determined that he would never be found wanting in the way of personal exertions, physical and mental, but especially the former. Hard work he expected from others, those others being the free and the bond, guardians and guarded, who were his subjects, but then he was himself prepared to give his own hard work, fiercely hard work, to the good cause, the maintenance of absolute order and strict discipline.

* * * * *

It may not be amiss to digress here for a moment or two in order to glance at the manners, tendencies, and thoughts of the period when this soldier-commandant took over control of his post. The Reform Act had just been passed. That in itself marked a change in spirit compared with the previous century. Men were proposing to themselves to think in a more kindly way about their fellows and to act towards them in a more tolerant fashion. I refer to the governing classes, those in whose charge, to a great extent, hung the welfare, the health, the chance for any happiness in life, of the masses of the people. The harsh, cruel age of the previous hundred years had been found to be all wrong, unrighteous in fact. But laws and habits are not to be changed all at once, and those brought up during the first years of the 19th century could not be expected to alter their modes of thought and action in a moment. To invert an old saying: "Nobody becomes utterly benevolent "all at once," and public opinion prefers steady rather than rapid progress, knowing that reformers may be very unscrupulous at times. Least of all was it to be expected that the system of punishing those convicted of crimes, in prison ships, houses of correction or penal establishments, would be altered with ill-considered haste. Nevertheless the preaching of Wesley, the books of Howard the philanthropist, and the work of Wilberforce and of Mrs. Elizabeth Fry, were beginning to have their effect. These influences began to modify the ideas even of legislators, and the law which in 1827 made the use of man-traps and spring-guns illegal affords one proof of the working of a more liberal spirit. One historian, referring to a certain statesman's efforts towards reform, puts it thus: "Peel will be remembered for "many salutary changes during his tenure of the Home "Office (1822-1827, 1828-1830). He reformed the criminal "code (especially by drastically reducing the 200 offences for

"which capital punishment could be inflicted), and criminal "procedure; systematised the functions of juries; improved "the condition of the gaols; and established in London a "new police force." The same writer remarks later on: "The growth of a new feeling of refinement was shown "in the passing of an Act (carried in 1833 and two years "afterwards extended to the whole county), which made it "illegal to drive any ox or cattle, or to bait any bull, bear, "badger, or other animal, or to fight cocks within 5 miles "of Temple Bar."

Thus we see that in that first part of the nineteenth century the dingy figure of Justice had been subjected in England to a spring cleaning, and the bandage over her eyes, intended to blindfold her, rendered more effective for that purpose. We may be proud of the fact that the process has continued, but with increased vigour.

* * * * *

It was at such a time, then, that Captain Booth took command at Port Arthur. His training, like that of the Lieut.-Governor, had made him a strict disciplinarian, and a perusal of his journal will, I am sure, convince the reader that here was a firm, perhaps even a stern official, one determined to carry out his duties without departure from the rules and regulations fixed by the system. In other words, the Commandant was a servant of the system, and he felt it his duty to bend all others to the same code. It seems certain, however, that if he was compelled to be harsh in his treatment, he was equally desirous of being just under the terms and conditions of the system. Like Dr. Temple (3) and the schoolboy, if Booth appeared to the prisoners as a "beast," he was a "just beast." The conditions under which they were expected to live in the penal establishment were made known to the convicts. The consequences of departure from rules were explained to them. If they chose to err, then punishment, severe and strict, but according to the law, would certainly follow. Notwithstanding this, my own impression is that Booth was as kind to the unfortunate beings in his charge as it was possible for him to be.

To make himself a complete master of the situation the Commandant set himself to work to learn every detail about the geography of the peninsula. Not content with making a complete circuit by land, he took journeys by

(3) Afterwards Archbishop of Canterbury.

water in a whale-boat from the Settlement round Tasman Island to Eagle Hawk Neck, and from Wedge Bay round Cape Raoul to the Settlement. One land journey along the shore from Fortescue Bay to Eagle Hawk Neck, in 1834, is described at some length. It took four days to accomplish, and the party of three (it included the Doctor from the Settlement) was nearly exhausted from starvation when it reached the Blow-hole and "nearly eat Macgregor out of "House" at the Neck. The characteristic entries are as follows: "Found three parties had been sent out in all direc-"tions, with provisions, as we were given up—it afforded "me very infinite pleasure to see the interest that our "situation had excited—even to the most depraved of the "Prisoners," and again—"Found a number of gaol-birds, "but from the general good feeling evinced by the Prisoners "I gave them all a *Benefit*—not after the usual manner. I "omitted to mention that this last expedition completed my "tour of the Peninsula, '*per terrâ et mare*'."

The journal is in the main one long string of records of movement between the Settlement and outstations. In November, 1834, he felt so fit from the exercise of long inspection walks that he proudly recorded, after a 50-mile trip: "Open to the world for a cool £50 to go on foot the "distance of 50 miles, within 12 successive hours."

When, after some years, roads were improved, a riding horse was kept for some sections of the rounds, but walking continued to be the principal means of locomotion. A twelve-hour day must have been the average working day for the Commandant when on tour. It is evident, however, that he was not a good bushman; once off the track he seemed to lose direction, and he had several escapes from being lost. One such occasion will be referred to later.

A feature that will strike a reader of this journal is the choice made of descriptive expression. The writer preferred to use picturesque terms to express himself, if such could be found. The following are some instances: "Piscatorising with the Seine" means, of course, "fishing." "A Brace of Lads off for a Slaunt" signified the absconding of two convicts. "Walked into the Bowels of the Earth" was his expression for descending one of the coal mines started in his time (May, 1833). "Ration'd at the Com-"missariat" was his way of noting down that he had dined with the Assistant Commissary and his wife. "To operate "on flint and steel" pictured the lighting of a fire. In re-

ferring to punishment for some offence he wrote "Visited "them with appropriate rewards for their conduct." A "Peruke," by a play on words, indicated an official rebuke. This method of clothing the ordinary occurrences of a somewhat monotonous life of routine was probably resorted to in order to give a little colour, a something of variety in thought and word, to what might otherwise have seemed to the writer "a bald and uninteresting narrative." One is reminded of a person in a very different sphere of action, Dick Swiveller, who, as Charles Dickens has told us, "sought the "downy," while others merely went to bed, and who "had "some of the rosy," when his friends indulged in wine. That this officer of Fusiliers had a liking for poetry is shown by numerous extracts admired sufficiently to be copied into the journal, and there are indications that some verses were of his own composition.

Captain Booth could enjoy conviviality on certain occasions, but it must not be carried to excess, and he would express in his notes playful disapproval of any lack of restraint on the part of his associates. Opportunities for hospitality were more frequent than one would have expected, considering that Port Arthur from its position and its purpose was not easy of access. Visits of the Lieut.-Governors, Colonel Arthur and Sir John Franklin, are described, and the Commandant has recorded with justifiable satisfaction the praise expressed by those officials for the results obtained by his measures and by his efficient methods of control. Perhaps he enjoyed most of all having as guests brother-officers from the troops stationed at Hobart. But even on such occasions attention to regulations had to be observed, as the following entry shows: "22nd March, 1834. "Introducing Wharton (4) and La Motte to the Work Shops "—great difficulty in preventing the Rules being digressed "(a prisoner being at large, no shooting allowed)."

This intense determination to have the machinery of the system run smoothly and with the regularity of finest clockwork was bound to have its reactions when something occurred to disturb the balance. Here are three consecutive entries which should not be missed:

"28th Jan. 1837. Received communication enough to "break my heart after all my efforts."

"31st Jan. Heartbroken and miserable."

(4) Wharton was afterwards drowned at the mouth of Little Swan Port, July, 1837.

"1st Feb. My poor heart a little relieved, but still greatly "harassed."

Now these might be taken as cries from the soul of a man desolated by a deep personal loss, such as the death of a beloved one. What, then, are they in reality? In the case of Captain Booth, with his mercurial temperament and passionate ardour, they express his grief—and it is very personal—because two convicts had broken through the supposedly rigid barriers, natural and artificial, surrounding the penitentiary, and had succeeded in getting away to the mainland.

Booth could appreciate and encourage the efforts of ministers of religion for the benefit of those in his charge, as the following items, in characteristic vein, will show:—

"25th Nov., 1833. Cutter *Shamrock* came in with Messrs. "Backhouse & Walker, Quakers, travelling with authority, "to visit different establishments; provoked them to take "up their quarters with me—after Breakfast danced them "through the Settlement and up to Mt. Arthur.

"26th. Suspicious looking morning, but notwithstanding "ventured with my companions of the Society of Friends "to visit Eagle Hawk Neck—got there about 11 a.m., well "drenched—made a good blow out and came back.

"27th. Friend Backhouse delivered a very good Dis- "course to the Prisoners—no labour this afternoon for "that purpose.

"28th. Went to the Chasm near the Bluff—got back "just in time for dinner. Friends Walker and Backhouse "took leave—rather pleased with them."

It is of interest to note that G. W. Walker, describing that visit in his Journal (Life and Labours of G. W. Walker), makes this comment: "The system now adopted at "Port Arthur, notwithstanding its severity, leaves a door "open for the deserving, or those who evince a disposition "to conform to the regulations of the establishment."

The following entries, referring to the visit of another minister, must not be omitted.

"30th Sept., 1836. Dr. Browning arrived from Town.

"1st Oct. Dr. B. addressed the Prisoners at considerable "length and to the purpose.

"2nd. Oct. Service by Dr. B.

"4th Oct. Dr. B. visited Point Puer and catechised, etc. "Addressed the Prisoners again this afternoon. Got his "pocket picked whilst at Settlement School this evening."

It would seem, therefore, that the Doctor's discourse failed to have due effect on one at least of his hearers.

Sufficient has been said to prove the value of the journal as a record of service, but I should like to mention several items which, though no doubt well marked in official documents and even in the Press of the period, might properly be included in this sketch of Captain Booth's personal notes of his "sovereignty." Thus he mentions that on the 25th of April, 1836, Lieut.-Governor Arthur laid the foundation stone of the Church at Port Arthur. On the 26th of July, in the following year, he writes that the first Service took place in the New Church, although this was not quite finished. The Railroad between Long Bay and Norfolk Bay, a work suggested by him, has already been mentioned. Concerning the Coal Mines, which were first opened out and developed by Booth, a good deal is written. Innumerable visits to these were paid by him. Then telegraphic communication with Hobart by Semaphore was established during his command. This required genuine hard bush work, which Booth was not the man to delegate to others, in order to find the hills best suited for the purpose. He appears to have been keenly interested in Steganography, and I believe that a code of his own invention was used for the signals.

We now come to what must have been the most terrible, the most trying episode of Captain Booth's life, the experience he had when "bushed" on Forestier's Peninsula. This deplorable adventure happened in May, 1838. His notes, no doubt written after the event, and when recovering from the effects of exposure and hunger, show some confusion as to the dates, but that is not surprising. On the 24th of May he started out from the Settlement with his pack of dogs to visit the Whaling Station at Blackman's Bay. Getting as far as the Sounds, he and the convict servant with him "bivouac'd" in the bush. On the 25th, after the dogs had hunted a kangaroo, the two men lost their way. During this day the servant managed, perhaps purposely, to get separated from his master. Food was finished, and Booth, not a good bushman, found himself in difficulties and was compelled to camp in a swamp. As rain had set in he was unable to light a fire, and being lightly clad the situation was serious. Then followed two days of misery, his state becoming worse and worse from lack of food and warmth,

the nights at that time of the year being extremely cold. He hardly expected to survive through the night of the 27th. On the 28th his condition was pitiable; he had lost the use of his feet and his hands, and having been without food for fully three days his strength had given out, yet he did manage with a supreme effort to crawl down a hill and to extricate himself from the depths of the dense bush he had occupied the previous day. At noon he heard gun shots and a bugle, and at three o'clock that afternoon he was found by one of the numerous rescue parties that were searching the peninsula in all directions.

In reality he owed his escape from death to his dogs, which had stuck to him all the time, and when the rescue party came in sight attracted its attention. It was impossible to move the sufferer that night, so he was made as comfortable as possible in a sheltered spot. Next day a litter was obtained from Dr. Imlay's hut at Lagoon Bay, about three miles away, and he was carried there. He was then transported by boat to East Bay Neck, and by another boat to Norfolk Bay, and so by the tram-line to the Settlement.

Captain Booth finished his record of this event with these words: "Altogether I received such marks of good "feeling towards me and generosity of Heart—that words "can scarcely express my feelings, and when the bustle sub-"sided and I was once again reclined in my humble apart-"ments were these feelings less exhibited by my faithful "servant and his family—whose anxieties had been very "great. The good feeling also represented to have been "evidenced by the Prisoners and wretched little Boys at "Point Puer also speaks greatly in behalf of their still pos-"sessing some latent sparks of good—which, if only worked "on firmly and rigidly, yet kindly—much good, it is to be "hoped, may be done."

It is worthy of note that Lady Franklin, in a letter to her sister, dated the 21st June, 1838, and one of the series that has lately come into the possession of the Royal Society, makes this reference to the episode:—

"On the evening of the ball news was brought up from "Port Arthur (a penal settlement of great interest and "importance) that Captain Booth, its Commandant, had been "four days missing in the Bush, and it was supposed had "perished. The two Military Officers under him, stationed "at different outposts of the settlement, were on leave of "absence for different reasons, and that night at the ball, "so that the settlement (containing a large number of con-

"victs of the worst description with only 50 soldiers to "control them) was left without any head except that of a "sergeant and a Deputy Commissary, the former having the "sole command of the troops. Great was the consternation "this news occasioned, not only on account of the extra-"ordinary merit of Capt. Booth, but on account of the prob-"ability of the convicts rising *en masse* under such favour-"able circumstances; our early disappearance from the ball "was attributed to this circumstance, for rumours of the "disappearance of Capt. Booth had been conveyed to his "junior officers at the ball room in some pencil lines written "from the settlement, before the telegraphic notice, or any "other, had reached Sir John's ear.

"The two young officers were sent for from the ballroom "—the *Colonial* schooner was ordered to prepare for sailing "at dawn of day—and these, another officer with a rein-"forcement of 30 soldiers, and buglemen for the bush, were "dispatched on board of her. The next morning the Tele-"graph said that Capt. Booth was found, without stating "whether dead or alive, and in this ignorance, but with "every hope of his being safe, the *Conway* frigate (fresh or "jaded from the ballroom) set sail for Sydney, proposing to "put into Port Arthur on her way. In the course of the "day we learnt to our great delight that Captain Booth "had been found *alive* in the bush, where he had lost his way "apart from his convict companion, who, having been pun-"ished a few days before, it was suspected had murdered "him. He was frost bitten and deplorably weak, having "been without food or drink for four days, unable to fire his "pistols, or to answer the coo-ies (the usual bush cry) or the "bugles which occasionally reached his ear. His Kangaroo "dogs, which were his faithful companions, acted for him, "*they* heard and answered the bugles, and brought the pur-"suers to the rescue.

"Sir John has laid a strict injunction, or, rather, *com-"mand* on Capt. Booth never to go into the bush again un-"accompanied by an orderly to watch his footsteps; for, what "with his daring, fearless nature, and his absence of mind, "which is always at work upon the interests of the settle-"ment (wherever he may be in the body), this is the third "or fourth time the same accident has happened to him."

I do not know to what extent Capt. Booth carried out the injunction so considerately laid on him for his own sake by Sir John Franklin. We may safely assume that after such an experience he would take far greater care in future

expeditions, and this for another reason than the Governor's command, namely, the influence and will of a still higher authority.

The journal closes abruptly on the 29th of August, 1838, but the last pages describe a visit to Hobart, and it was during those few days that he became engaged to be married. (5) I think we may close this review with a final extract, that of 8th of August. "Had a most delightful ride as far "as O'Brien's Bridge, escorting L. Once happy in my life. "Came across Sir John; obliged him to side for it, a capital "old fellow. Dined at Government House."

* * * * *

It only remains now to relate how it came about that Extracts from Captain Booth's journal were made available for the Royal Society. I have given elsewhere (6) an outline of the occurrence, but as, for certain good reasons, no names whatever were then mentioned, the story here set forth is new in the sense that it is now furnished with the details that properly belong to it. It will be admitted, I think, that it is not lacking in that touch of the romantic which manifests itself for our benefit and our enjoyment when the present and the past, each with its own ideas and impulsions, are brought into association. Illuminating the present little instance of the process, there is the thought that it is what we ourselves bring to our studies of the past that to some extent secures for us the fascination we find in them.

One day in the summer of 1923 Major J. A. Richmond, formerly of the South Staffordshire Regiment, who fought in East Africa in the Great War, was seated in his Club in Pall Mall. He was turning over the pages of an illustrated paper, when he came across the picture of a ruined church. It was the church at Port Arthur. It flashed across his mind that he knew something about that building, for the laying of its foundation stone was referred to in his great-uncle's diary. This journal had only come into his possession a couple of years before, having been bequeathed to him by his great-uncle's daughter, Miss Amelia Patricia Booth, (7) who was born at Port Arthur on the 25th of August, 1839.

[(5) Captain Booth married Miss Elizabeth Charlotte Eagle at Hobart on 20/11/1838.—Ed.]

(6) *United Empire*, December, 1923.

[(7) Miss Booth visited Tasmania in 1909, and upon her return to England she sent out to the Society the Signal Book compiled by and used by Captain Booth at Port Arthur.—Ed.]

She had died in September, 1920, and although he had been too busy to study the book closely he had skimmed through it, and remembered the reference to the church.

Then Major Richmond began to consider. The journal was, of course, a private family record. There were parts of it which were of a purely personal nature. But other parts, those, for instance, dealing with the years spent as a Commandant at Port Arthur, surely might be of some historical value for all in Tasmania who cared for such things. At any rate, it should be easy to find out if that was so. Thereupon Major Richmond went to the Tasmanian Government Office and offered to lend the book to the Agent-General in order that any sections of it relating to Tasmania might be copied out. This opportunity was eagerly seized by Mr. Ashbolt, who saw at once that such a work might contain quite important matter, and that the private views of an official placed in a very responsible position would be a welcome and useful supplement to the public documents of the period covered by the diary, that is, from 1832 to 1838. There was another feature of the case that attracted, one might almost say, excited, the Agent-General. Major Richmond's proposition nearly coincided with the very handsome donation of Franklin Papers, the second of its kind, made by Mr. W. F. Rawnsley to the Royal Society. This feeling was enhanced, when it was noticed, as happened at once, that in one of Lady Franklin's letters to her sister there was a reference to Capt. Booth. What she had to say about him has already been stated. Major Richmond was pleased to have the copy of that letter, which was offered to him.

Following in Mr. Rawnsley's footsteps, the owner of the journal desired that any extracts taken from it should be presented to the Royal Society. It fell to the lot of the writer of these "Notes" to make those extracts, and as he read the whole diary and received permission from Major Richmond to utilise any passages and episodes in it other than those associated with Tasmania, it will be easily understood how and why the "Notes" came to be written.

EXPLANATION OF PLATE XI.

Figure 1.

Mrs. Charles O'Hara Booth (formerly Miss Elizabeth Charlotte Eagle).

Figure 2.

Captain Charles O'Hara Booth, 21st R.N.B. Fusiliers. Photograph taken from oil painting in the Tasmanian Museum. On the back is written, "Capt. Booth, 21st R.N.B. "Fusiliers. Painted 1836 by T. J. Lempriere, Dept. Assist "Coms. Gen."

Apparently both portraits were painted by Mr. Lempriere at Port Arthur, Capt. Booth in 1836, and Mrs. Booth at a later date. The paintings are the property of Mr. Bernard Walpole, who placed them on loan for exhibition in the Tasmanian Museum and Art Gallery.

NOTES ON SOME RARE AND INTERESTING CRYPTOGAMS.

By

L. RODWAY, C.M.G.,

Government Botanist, Tasmania.

(Read 9th November, 1925.)

Among the enthusiasts who have pushed the study of plants to its present high level, few have done much research amongst the lower groups, especially the fungi. Little more has been done than could be classed as simply scratching the surface. There is plenty of new material at hand ready for the worker. The only trouble is that sometimes when returns are copious it is not always easy to induce an estimable society to publish it.

The plants brought before you in the present paper are of exceptional interest, though few. The Hepatics here described by Pearson are the last lot collected by our old friend, W. A. Weymouth. Pearson, who died only a short time ago, was for many years a corresponding member of this Society.

Terfezia tasmanica, n.s. An irregular subterranean tuber, just emerging from the ground when mature, usually 1-3 cm. diameter, chestnut-brown, tough fleshy. Pileus with an obsolete stem piercing the centre of the tuber, tough fleshy, made up of bold convolutions with thick walls opening at the base by the side of the stem. Hymenium lining the internal surface of the convolutions. Asci 8-spored, globose-pyriform, minutely echinulate, coat thick, forming a double contour, hyaline till old, then brown, 20 μ. diameter.

Slopes of Mt. Wellington, 300 ft.

Xylaria tolosa, n.s. Sporophore usually arising with a long root from a loose subterranean sclerotium; erect, black surface, white and dense internally, about 4-6 cm. tall, the sterile stem rather flat at least when dry, about 2-3 cm., slender; fertile portion slightly thickened about 1-5 cm. Perithecia small, immersed, only the osteoles protruding; apex attenuated and sterile; asci narrow, cylindric, 8-spored; spores black, ellipsoid, oblique, smooth, 13 x 6-7 μ.

Near to *X. deceptiva* of Lloyd. Located at Tolosa, also at Morialto Gorge, near Adelaide.

Gymnomycis megasporus, *n.s.* Tuber about 1 cm. diameter, rugose, brown to pale, rather dense; gleba pale, peridium absent, tubes small, much contorted. Spores globose, hyaline, surface of a dense coat of short clubs, 15-20 μ. diameter.

No doubt near *G. seminudus*, but complete absence of peridium, the dense coat of short clubs, and size of spores make it very distinct.

Melanobotrys, *n.g.* Perithecia sessile on a divided tree-like stem arising from an enlargement of the bark of the tree, black, the perithecia globose, free, 0.5 mm. diameter, no osteole; spores dark brown, smooth, uniseptate, 12 x 3 μ.

Melanobotrys tasmanicus, *n.s.* Growing on a gall expanded on the stem of *Nothofagus cunninghami;* the branches about 5-8 mm. high. Apparently the fungus perennates in the surface wood, causing a pulvinate enlargement.

West Coast, on stems of *Nothofagus*.

Hyphoscypha coccinea, *n.s.* Discoid, obtuse, margin thick, waxy; disc orange-red, slightly concave, 2-6 mm. diameter, margin and external surface pale, covered with short hyphal protuberances. Asci linear cylindric; spores eight uniseriate, oblong, obtuse, at first hyaline, smooth, 16 x 8 μ. When mature rather larger and armed with coarse asperities.

On rotten wood, National Park, 1,000 ft. altitude.

Hyphoscypha is pretty close to *Dasyscypha*, but differs by the external surface being rough with hyphal protuberances, instead of spreading cottony hairs.

Amongst Hepatics besides the new species forwarded by Pearson I desire to record the great variability of *Aplozia* (*Solenostoma*) *rotata*, Mitton.

Aplozia (*Solenostoma*) *rotata*, Mitt., is consistent in structure, but in colour and size varies greatly, according to surroundings. It is common for the tips of the branches to be deep red, but when growing in shade it is uniformly green. In exposed places on Mt. Wellington, also on Blue Tier, it is deep red and small, with leaves often less than half a millimetre diameter, but at Lake Petrarch and Snug River it is vivid green, and leaves often exceeding two millimetres.

This difference in size of leaf would be of little interest if happening to the organs of one of the higher plants, but mosses and fungi are supposed to be more uniform in size, and many a new species has been recorded for less distinction than occurs in this species.

In the Kew Bulletin No. 2, 1924, there appeared a paper on Tasmanian Hepatics by Mr. Pearson, in which are described some new varieties and species. It may interest local students if a short reference to these is made.

No record of most localities is made.

Lophocolea heterophylloides, Ness. This is admittedly a very variable plant. Pearson marks two forms as being distinguished from the type. Var. *decurrens* distinguished by its larger and very decurrent leaves, and some stems appearing to be winged, and its large underleaves.

Var. *macrocalyx*. Only differing from var. *decurrens* in having a very large involucre.

Symphyomitra weymouthii, Pearson. Sterile, small, pale green, whitish below, loosely cæspitose. Stem prostrate, simple or slightly branched, very tender, antical side plane, postical rounded, 8 x 6 and 6 x 4 cells, cortical cells similar to the inner; branches lateral, slightly postical, arising from below the leaf, radiculose, rhizoids hyaline, straight, ascending to apex of the stem; flagelliferous, flagellæ postical microphyllous, radiculose. Leaves horizontally inserted, imbricate, slightly concave on plane, broadly ovate, oblong-ovate or roundish-oblong-quadrate, entire or retuse, upper (postical) margin extending to middle of the stem, lower leaves smaller bifid; cells medium size, 4-5-6 sided; walls thin, no trigones.

Dimensions: Stem, 1.3 to 2.5 cm. long; diam., .2 mm., with leaves 2.25 mm. wide; leaves, 1.5 mm. x 1 mm., 1.25 x .9 mm.

Lophocolea bicuspidata, Pearson. Monœcious, medium size, dark to dull green in colour, loosely cæspitose. Stems irregularly and sparingly branched. Leaves sub-opposite horizontal to patent, antical margin long decurrent, straight or slightly curved, postical margin, curved long triangular, margin entire, apex 5-6 times narrower than the base, bicuspidate segments acuminate, upper larger than the lower, sinus rounded; texture delicate, cuticle slightly papillose; cells medium sized quadrate, walls thick, trigones minute. Underleaves large, connate, with both leaves or one only,

rarely free, broadly cuneate or subquadrate, rather broader than high, bifid to about 1/3, sinus rounded, segments with two or more teeth on the exterior sides.

Perianth projecting a little beyond the bracts, oblong, trialate, wings broad, spinulose-dentate, mouth spinulose-dentate.

Plagiochila hartziana, Pearson. Diœcious. Medium size, dark brown in colour, cæspitose. Stems simple or slightly branched, firm. Leaves alternate, imbricate or approximate, horizontal, broadly ovate or rotund, entire or with from 1-4 acute teeth, lower margin very decurrent, usually straight, upper margin rounded, ampliate, extending to the middle of the stem, only slightly decurrent, apex rotundate or acute (unidentate) or with several teeth extending to the upper margin; cuticle smooth, polished; cells medium 4-5-6 walled; walls firm, angles thickened, no trigones.

Metzgeria concavula, Pearson. Diœcious, small, pale green, densely stratose-cæspitose, corticolous. Fronds repeatedly dichotomous, angle patent, margin much decurved, almost revolute, wing 12-celled, wide, rarely 15-20, sparingly setose, margin setose, setæ in pairs, more rarely single, straight or some nearly hamate, somewhat short and coarse, costa narrow, slender, two antical and two postical cortical cells; on cross section somewhat rather broadly oval, 4-6 cells; near the fork postical cortical cells 3 setose, densely so on some portions of fronds; cuticle slightly papillose. Calyptra long clavate, pilose. Gemmæ abundant, marginal or rarely on the postical side of costa, usually oval-ligulate, but various in shape, disciform or stipitate, but all more or less remarkably concave. Apart from the gemmiferous character of the plant, it differs from *M. nitida*, Mitt., which has also a costa of two antical and two postical cortical cells, by its less transparent cells, thickened walls, smaller trigones, presence of setæ on the wings, hardly papillose cuticle, shorter and stouter setæ; in *M. nitida* they are very long and delicate.

As Mr. Pearson quotes *M. nitida* of Mitten, it may be well to include, from Prof. Evans, the greatest authority of the genus, the following note:—

> I am unable to separate *M. nitida*, Mitt., from the widely distributed *M. hamata*, Lindb. In a paper on Chilian *Metzgeriæ* I have definitely reduced *M. nitida* to synonymy under *M. hamata*. There seems to be no reason for recognising the validity of *M. nitida*.

NOTES ON TASMANIAN ARANEIDÆ

(With a description of a new species).

By

V. V. Hickman, B.Sc. (Tas.).

Plates XII.-XV. and Seven Text Figures.

(Read 9th November, 1925.)

In the following notes I have adopted the method of description employed by Rainbow and Pulleine in their excellent account of Australian Trap-door Spiders (D), and can only hope that my descriptions will be as clear as theirs are.

Family AVICULARIDÆ.

Sub-Family *DIPLURINÆ.*

Group Diplureæ.

Genus *Chenistonia* (Hogg).

Chenistonia trevallynia, sp. nov.

Plates XII. and XIII.

The genus *Chenistonia* was established by H. R. Hogg, in 1901 (A), for the reception of two species which he found at Macedon, Victoria. Since that date, five other Australian species have been described, making a total of seven, namely:—

Chenistonia maculata (Hogg) } .. .. (A)
Chenistonia major (Hogg) . }
Chenistonia tepperi (Hogg) .. .. (B)
Chenistonia hoggi (Rainbow) } .. .. .. (C)
Chenistonia giraulti (Rainbow) }
Chenistonia auropilosa (Rainbow and Pulleine) } (D)
Chenistonia villosa (Rainbow and Pulleine) }

The following notes deal with a Tasmanian spider of this genus. The writer believes that it is a new species, and also that it is the first member of the genus *Chenistonia* to be recorded from this State. The name, *Chenistonia trevallynia*, is suggested, from the locality where the specimens were obtained.

The description of the male is as follows:—

Measurements in millimetres (excluding the falces).

Length of Cephalothorax	4.9
Breadth of Cephalothorax (across fovea) ..	3.7
Length of Abdomen	4.3
Breadth of Abdomen	2.8

Leg	Coxa	Trochanter and Femur	Patella and Tibia	Metatarsus and Tarsus	Total
1	1.8	3.6	4.3	3.7	13.4
2	1.5	3.2	3.5	3.7	11.9
3	1.2	2.6	2.8	3.3	9.9
4	1.6	4.0	4.3	4.6	14.5
				Tarsus	
Palpi	1.7	2.6	2.8	0.9	8.0

Cephalothorax: Obovate, dark brown, arched, and sparingly covered with fine, short, down-lying, black hairs.

Pars Cephalica: Narrow in front, gently ascending, smooth. The segmental groove is distinct.

Ocular Area: This forms a well-defined tubercular eminence, 0.7 mm. broad, and 0.5 mm. long. In front of it projects a tuft of six or seven long black bristles. Behind the front median eyes, and between the rear median eyes, there is another tuft of shorter bristles.

Clypeus: Narrow and brown in colour.

Pars Thoracica: Arched and broad, with distinct radial grooves.

Thoracic Fovea: Deep, straight, and situated two-thirds of the length of the cephalothorax from the anterior end.

Marginal Band: Narrow, fringed with a few scattered hairs.

Eyes: Set on an oval prominence, which is black in colour, and one and a half times as broad as it is long. They form a very compact group. The front median eyes are separated from each other by a distance equal to one-third of their individual diameter. The front laterals are the largest of the group, and have a long diameter equal to one and a half times that of the front median eyes, from which they are separated by a distance equal to one-fifth of the diameter of the front median eyes. The front row is procurved, while the rear row is recurved. The long diameter of the rear laterals is slightly less than that of the front laterals, and is equal to that of the rear median eyes. The rear laterals just touch the nearest point of the front laterals, and of the rear median eyes, and the black rims, on which these eyes are mounted, merge into one another between the eyes. *See fig.* 1.

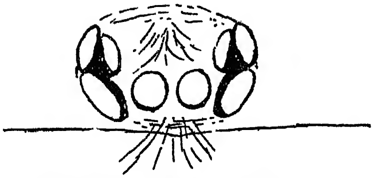


Fig. 1. *Chenistonia trevallynia.* Eyes in male.

Legs: Similar in colour to the cephalothorax. They are densely clothed with dark hair, but on the upper side of each patella there is a bare longitudinal stripe. Spines are present on legs 2, 3, and 4, and are especially numerous on the metatarsi of legs 3 and 4. In the case of leg 1 there are only a few spines on the upper side of the femoral segment, while the tibial segment carries the apophysis, and powerful spine so characteristic of the genus. Near the base of the apophysis there is a second smaller spine. *See fig.* 2. This second spine was present in each of the nine

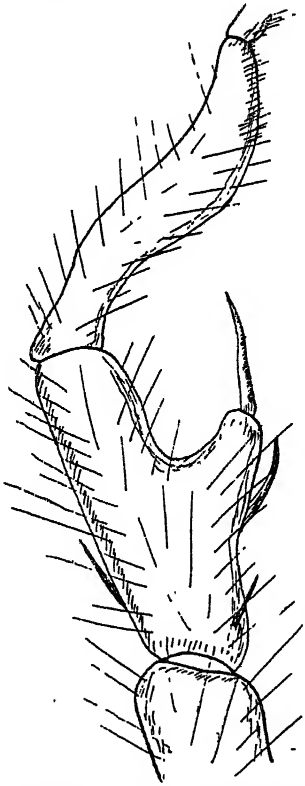


Fig. 2. *Chenistonia trevallynia.* Tibia and metatarsus of leg 1 in the male.

males examined. One abnormal specimen had a powerful double spine rising from the apophysis on the tibia of the right leg, and no spine at all on that of the left leg. The tarsi and metatarsi of legs 1 and 2 are scopulated. No spines are present on any of the tarsi. The superior claws are pectinated in two rows, there being about nine teeth in the inner rows, and twelve in the outer rows. The inferior claw is short and bare.

Palpi: Concolorous with the legs and thickly covered with hairs. The tibial segment is provided with spines and coarse bristles. The bulb is pyriform, and ends in a sharp point. Near the extremity, and on one side, there is a sharp thorn-like projection. *See fig.* 3.

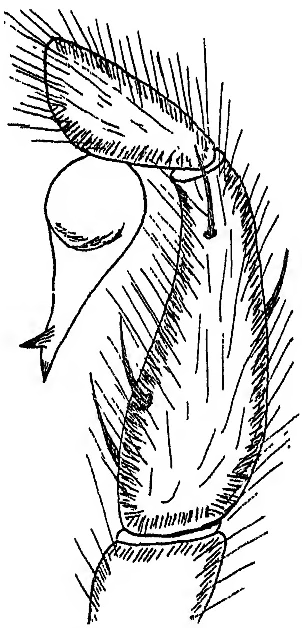


Fig. 3. *Chenistonia trevallynia.* Left palpus of male viewed from outer side.

Falces: Concolorous with the cephalothorax. Densely clothed with fine black hair and coarse bristles. No rastellum is present. The fang is long, well curved, and of a dark red-brown colour. The inner edge of the falx sheath is armed with a row of eight large teeth, and there are five or six minute intermediate teeth near the base.

Maxillæ: Light brown, not very broad, excavated round the labium, and in the excavation there is a cluster of about 37 short blunt spines. The heel is rounded. The beard is red.

Labium: Submerged, devoid of spines, but clothed with long coarse hairs. The apex is slightly rounded.

Sternum: Oval, arched, hairy, and fringed with black bristly hairs.

Sigilla: Very small, marginal, and not well defined.

Abdomen: Light brown mottled with dark brown, and thickly covered with long black hair. The under surface is fawn in colour, and covered with short black hair.

Spinnerets: Yellow and hairy. The superior pair long and tapering. The second segment is the shortest, while the first segment is equal in length to the third. The inferior pair are short, cylindrical, and about their own individual diameter apart.

The description of the female is as follows:—

Measurements in millimetres (excluding the falces).

Length of Cephalothorax	4.4
Breadth of Cephalothorax (across fovea) ..	3.4
Length of Abdomen	6.4
Breadth of Abdomen	4.3

Leg	Coxa	Trochanter and Femur	Patella and Tibia	Metatarsus and Tarsus	Total
1	1.9	3.6	3.7	2.8	12.0
2	1.7	3.2	3.2	2.6	10.7
3	1.4	2.8	2.6	3.0	9.8
4	1.7	3.9	4.1	3.9	13.6
				Tarsus	
Palpi	1.7	3.1	2.6	1.4	8.8

Cephalothorax: Lighter shade of brown than in the male; longer than broad, rounded at the sides, and thinly covered with short black hairs.

Pars Cephalica: Narrow in front, and gently ascending at the sides.

Ocular Area: Forms a well-defined oval eminence as in the male. It is 0.8 mm. broad, and 0.6 mm. long, and pro-

vided with a tuft of bristles in front of the anterior median eyes, and another tuft between the rear median eyes.

Clypeus: Narrow and hyaline.

Pars Thoracica: Broad, arched, radial grooves well defined.

Thoracic Fovea: Deep, straight, and situated as in the male.

Marginal Band: Narrow and without any distinct fringe.

Eyes: Arranged in a compact group on a raised tubercle as in the male. The front median eyes are the smallest of the group, and are separated from each other by a distance equal to half their individual diameter. The front laterals are the largest of the group, and their long diameter is equal to twice the diameter of the front median eyes, from which they are separated by a distance equal to one-third of the diameter of the front median eyes. The front row is procurved, while the rear row is recurved. The long diameter of the rear laterals is equal to about four-fifths that of the front laterals, and the long diameter of the rear median eyes is equal to one and a fifth times the diameter of the front median eyes. The rear laterals almost touch the nearest point of the front laterals, and of the rear median eyes; and the black rims, on which these eyes are mounted, merge into one another between the eyes. *See fig.* 4.

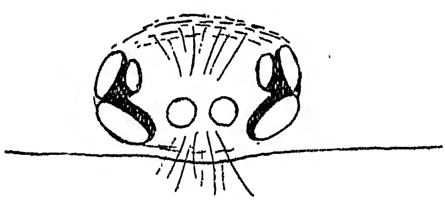


Fig. 4. *Chenistonia trevallynia.* Eyes in female.

Legs: Concolorous with the cephalothorax, moderately hairy. All of the metatarsi are furnished with spines, but those of legs 3 and 4 more densely so than the others. There are no spines on the tarsi. A scopula is present on the tarsi of legs 1 and 2. On the upper surface of each patella is a bare, light-brown, longitudinal stripe. The superior tarsal claws are pectinated in two rows; there are seven teeth in each row. The inferior claw is small and bare.

Palpi: Moderately strong and long. They are similar in colour and clothing to the legs. The tarsal segment is thickly scopulated, and provided with a single claw, having five pectinations.

Falces: Concolorous with the cephalothorax or darker; clothed with black hairs and coarse bristles. The inner ridge of the falx sheath is armed with a row of eight large teeth, and there are five or six minute intermediate teeth near the base. The fang is long, shining, and well curved. It is dark brown in colour. There is no rastellum.

Maxillæ: Light brown, not very broad; excavated round the labium, and in the excavation there is a cluster of about 37 short blunt spines. The heel is well rounded, and the beard reddish in colour.

Labium: Submerged, devoid of spines, but clothed with long coarse hairs. It is separated from the sternum by a groove.

Sternum: Light brown, arched, and hairy, fringed with short black bristles.

Sigilla: Small, round, marginal, distinct in mature specimens, but scarcely visible in young specimens.

Abdomen: Oval, light brown, mottled, with irregular dark brown spots and blotches. Thinly clothed with short and long black hairs. The anterior portion of the abdomen slightly overhangs the base of the cephalothorax. The lower surface is fawn in colour, and marked with two transverse rows of irregular brown spots.

Spinnerets: The superior pair are yellow, hairy, and tapering. The second segment is the shortest, while the first and third are about equal in length. The inferior pair are small, cylindrical, and slightly more than their own individual diameter apart. They are also yellow and hairy.

Locality: Trevallyn, Launceston, 11th September, 1925.

Field Notes: This spider makes a web under stones and logs, usually in damp localities. The web is a silken tube, which frequently branches into crevices in the ground, or in the log. Terrestrial Amphipoda, which are plentiful in damp situations, seem to form the chief food of these spiders. The male is usually found without a web, but sometimes constructs a tubular retreat under a log, just as the female does.

Family AVICULARIDÆ.

Sub-Family *MIGINÆ*.

Genus *Heteromigas* (Hogg).

Heteromigas dovei (Hogg).

Plates XIV. and XV.

The female of this species has been described by Hogg (E), who based his description on two specimens from Table Cape. The spider, however, is also found in the vicinity of Launceston. The male of the species is very seldom seen, and has never been described. The following account of a single specimen in the writer's collection may therefore be of interest.

Measurements in millimetres (excluding the falces).

Length of Cephalothorax	5.00
Breadth of Cephalothorax (across fovea) ..	4.75
Length of Abdomen	6.00
Breadth of Abdomen	4.00

Leg	Coxa	Trochanter and Femur	Patella and Tibia	Metatarsus and Tarsus	Total
1	2.1	6.0	6.0	5.2	19.3
2	1.9	5.2	5.0	5.0	17.1
3	1.6	4.0	4.0	4.0	13.6
4	1.7	5.5	5.5	7.0	19.7
				Tarsus	
Palpi	1.4	4.6	4.7	0.9	11.6

Cephalothorax: Slightly longer than broad; wide in front, but narrow posteriorly.

Pars Cephalica: Dark brown, almost black in colour; rounded in front, and does not rise so abruptly from the thoraçic fovea as in the female; segmental groove distinct but not deep.

Ocular Area: Extends more than half the width of the front of the cephalic part. Its breadth is more than twice its length. The front median eyes are on a slight elevation.

Clypeus: Wide, transversely wrinkled, and provided with a few short bristles.

Pars Thoracica: Moderately broad across the fovea, but becomes narrow posteriorly. It is slightly arched; the radial grooves are well defined. A few black hairs are visible, but the greater part of the surface is smooth and hairless. The colour is light reddish-brown.

Thoracic Fovea: Deep, wide, slightly procurved in the centre, with a tendency to recurvature at the ends.

Marginal Band: Broad and fringed with short black hairs.

Eyes: The front median eyes are separated from each other by slightly less than their own individual diameter, and from the front laterals by four-thirds that distance. The front laterals are poised obliquely, and their long diameter is slightly less than that of the front median eyes. The front row is slightly procurved, while the rear row is distinctly recurved and shorter than the front row. The long diameter of the rear laterals is a little more than two-thirds that of the front median eyes; while the long diameter of the rear median eyes is a little less than two-thirds that of the front median eyes. The distance separating the nearest points of front and rear laterals is equal to half the long diameter of the rear laterals; and slightly less than this distance separates the rear median eyes from the rear laterals. *See fig.* 5.

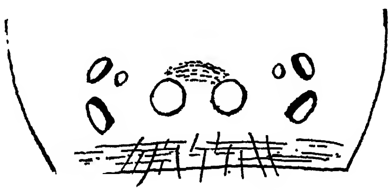


Fig. 5. *Heteromigas dovei* (Hogg). Eyes in male.

Legs: Tapering, brown in colour, thinly clothed with bristly hairs. Two longitudinal bare stripes are visible on the upper surface of the femur, patella, and tibia of each leg. There are no spines on the upper surface of any of the legs. Two small spines are present on the outer side of tarsi I. and II., none on tarsus III., and only a single small spine on the outer side of tarsus IV. The metatarsal and tibial segments of all the legs are bespined on the sides. In the case of metatarsi I. and II., there are about ten curved spines in a double row on the outer side, and on the inner

side a pair of spines near the distal end, a pair near the base, and two single spines in between. Three spines are present on patella I., one on II., and none on III. and IV. The femoral segments are quite devoid of spines. The superior tarsal claws have eight teeth in a single row; the inferior claw is minute and smooth.

Palpi: Long, similar in clothing to the legs, but no spines are present. The tibial segment is long and slender, and is more than five times the length of the tarsal segment. The bulb is large, and almost spherical. It is produced into a sharp, thin, well-curved style. *See fig.* 6.

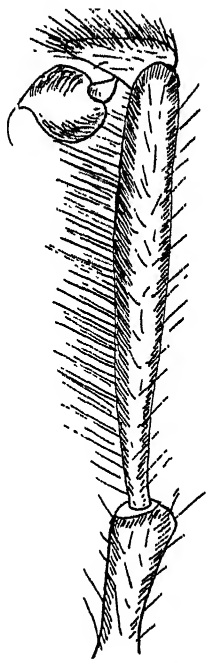


Fig. 6. *Heteromigas dovei* (Hogg). Left palpus of male viewed from outer side.

Falces: Short, very dark brown, almost black, in colour; they do not fall perpendicularly after a short horizontal portion as in the female, but slope gradually forward and downward in a gentle curve. The fangs are very strong, being reinforced with four ridges as in the female. There are four teeth on the outer, and four on the inner edge of the furrow, and five or six small intermediate teeth.

Maxillæ: Reddish brown, strong, broad; the lower outer corner rounded; no spines are present; the beard is red.

Labium: Slightly longer than broad, rounded in front, separated from the sternum by a well-defined groove; dark brown in colour, clothed with a few short black hairs, and with several long hairs at the apex. No spines are present.

Sternum: Pyriform, yellow, lightly clothed with black hairs.

Sigilla: The posterior pair are large, and placed near the central line. The other sigilla are not distinct.

Abdomen: Obovate, longer than broad, the anterior portion slightly overhanging the cephalothorax. The upper surface is dark grey, and clothed with black hairs. No patern is visible. The lower surface is yellow, and clothed with black hairs.

Spinnerets: Yellow and hairy; the superior pair are short, and appear to consist of only two segments. The first segment makes up almost the whole length, the second segment is reduced to a ring, and the third consists of a small dome sunk in the ring-like second segment. The inferior pair are small, cylindrical, and about one and a half diameters apart.

Locality: Mulgrave Crescent, Launceston, 4th October, 1925.

Field Notes: The male of this species was found under a stone in close proximity to the nests of several females. These nests are about 13 mm. in diameter, and go down almost vertically to a depth of about 220 mm. They are closed with a thin, neatly bevelled lid, and lined just inside the opening with a thin covering of silk. The lid is kept shut during the day time, and on attempting to open it the spider is sometimes found holding on to the inner side. Although there is no rastellum in this species, the female is able to dig a hole in the ground very quickly by means of the double rows of strong curved spines on her front legs. As soon as sufficient earth has been excavated to allow the spider to get into the hole, the building of the lid is commenced. The spider works inwards from the margin of the hole, gradually closing the opening with concentric rings of earth cemented together with silk. This cover is strengthened with layers of silk on the inside. It is then cut away

round the margin, leaving a hinge on one side. When the lid is finished, the work of deepening the hole is proceeded with. Digging operations are carried out at night, and in the morning little balls of earth may be seen scattered a few inches away from the nest. Frequently these balls of earth form the only indication of the presence of the nest. The accurately fitting lid, whose outside resembles the surrounding earth, renders detection almost impossible. The egg sac is round, cushion-shaped, about 11 mm. in diameter, and made of strong white silk. It is fastened to the side of the burrow about three-quarters of the way down from the opening, which is then sealed up until the young emerge from the sac.

Family ARGIOPIDÆ.

Sub-Family *ARGIOPINÆ*.

Genus *Arachnura* (Vins.)

Arachnura feredayi (L. Koch).

The female of this species is described and figured in L. Koch's classic work (F), under the name of *Epeira feredayi*. His specimens, however, came from New Zealand. At the Tasmanian Field Naturalists' Camp, 1923, the species was found by Dr. Pulleine, in the vicinity of the Tasman Memorial, on the South-East Coast of Tasmania. This is probably the first record of the spider occurring in this State, and, perhaps, in Australia, since it is not mentioned in Rainbow's census of Australian *Araneidæ* (G), although several closely allied forms are listed. There seems to be no published record of the male. This is also the case with most of the species of this genus found in other countries. Simon mentions a doubtful specimen from Ceylon (H). The minute size of the males probably accounts for their having escaped notice. The following description deals with a Tasmanian specimen of the male of *Arachnura feredayi* found near Launceston:—

Measurements in millimetres.

Total Length (abdomen contracted)	2.00
Length of Cephalothorax	0.70
Breadth of Cephalothorax (in middle) ..	0.70
Breadth of Cephalothorax (in front)	0.35
Length of Abdomen (Contracted), ...	1.65
Length of Abdomen (Expanded)	1.85
Breadth of Abdomen	1.10

Leg	Coxa	Trochanter and Femur	Patella and Tibia	Metatarsus and Tarsus	Total
1	0.20	0.55	0.57	0.60	1.92
2	0.16	0.52	0.55	0.55	1.78
3	0.11	0.35	0.35	0.40	1.21
4	0.16	0.52	0.55	0.55	1.78

Cephalothorax: As broad as long; margins well rounded; arched; narrow in front; yellowish brown in colour, with dark brown sides and a dark median stripe; clothed with a few scattered dark hairs.

Pars Cephalica: Not raised above the thoracic region; segmental groove indistinct.

Ocular Area: Broader than long; the portion on which the four median eyes stand projects over the anterior margin of the cephalic region. No fringe is present, but a few hairs are scattered over the ocular area.

Clypeus: Yellowish brown; wide; transversely wrinkled; sloping back.

Pars Thoracica: Broad; well arched; sloping sharply down under the anterior portion of the abdomen; radial grooves clear, but not deep; thoracic fovea distinct.

Eyes: The anterior median eyes are slightly larger than the posterior median eyes. The distance separating the anterior median eyes from the posterior median eyes is greater than that which separates the anterior median eyes from each other. The posterior median eyes are separated from each other by a distance equal to their own individual diameter. The lateral eyes of each side occupy a common prominence, and are separated from each other by about half their own individual diameter, and from the corresponding median eyes by about three times their own individual diameter. Front and rear laterals are about equal in size to the rear median eyes.

Legs: Yellowish brown; femur and tibia of each leg lightly clothed, tarsus and metatarsus more densely clothed with brown hairs. No spines are present on any of the legs. The tarsus ends in the usual three claws. Each of the paired claws possesses a row of four slightly curved teeth. Several terminal hairs are modified to form accessory claws.

Palpi: About 0.8 mm. long when unexpanded; thinly clothed with yellow hairs. The tarsal segment is furnished

with an accessory branch or paracymbium. The tibia is extremely short, being about equal in length to the patella. On the inner side of the femoral segment is a depression for the reception of the coxal spur. In the unexpanded bulb the slender terminal style is visible, and ends in a sharp black point. The medium apophysis with its serrated edge can also be seen. *See fig.* 7.

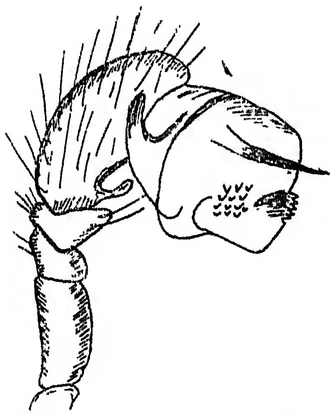


Fig. 7. *Arachnura feredayi* (L. Koch). Right palpus of male.

Falces: Yellowish brown in colour; furnished with a well-curved serrated fang. The basal segment is 0.12 mm., and the fang 0.1 mm. long. The inner angle of the furrow of each falx is armed with a row of three strong teeth, and the outer angle with one, while there are two small intermediate teeth. A few scattered dark-brown hairs are visible on the falces.

Labium: Yellowish brown, triangular, broader than long, one or two hairs at the apex.

Maxillæ: Yellowish brown, furnished with a well developed serrula. The beard is represented by a few long hairs on the inner margin. A short coxal spur is present on the outer margin.

Sternum: Yellowish brown, shield-shape, terminates in a rounded elongation between the fourth coxæ; clothed with a few dark hairs; length equals 0.55 mm.; breadth, 0.40 mm.

Abdomen: Pyriform; the anterior portion overhangs the base of the cephalothorax. The narrower terminal por-

tion is contractile, and in the contracted condition displays a number of transverse wrinkles. A few hairs are evenly spaced along the wrinkles. When the terminal portion is expanded, it forms a short tail, which ends in five blunt projections. This tail is relatively much shorter, and consequently less mobile than that of the female. The anterior margin of the abdomen is not cleft as in the female, but there is a slight projection on each side. The colour of the abdomen is light brown, with two darker areas, one on each side of a more or less rectangular region on the upper side.

Spinnerets: Brown, hairy, and surrounded by a single row of hairs. They occupy a position on the under surface of the abdomen a little more than half-way from its anterior margin in the contracted condition.

Field Notes: The males were found during the latter part of January, in the webs of the females. These webs are usually hung three or four feet from the ground, in a shady situation, near a creek. They are often found on the common gorse (*Ulex europeus*). Sometimes four or five webs are hung on the one bush. The snare consists of an irregular net-work of threads, in the centre of which is suspended at an incline an incomplete circular web 10 to 15 centimetres in diameter. This web is made up of about 20 to 29 radii, which converge to a meshed hub in the centre. Round the hub is a notched zone of three or four turns, and outside this a free space of about one centimetre. The radii, hub, and notched zone are made of non-viscid thread. Outside the free space is an incomplete viscid spiral. Three or four sectors above the hub are left open. Below the hub the spiral consists of 20 to 30 turns. To the radius which bisccts the open sectors, the spider frequently attaches dry leaves, twigs, etc., and behind these takes cover when disturbed. Here also is hung the string of egg cocoons, sometimes as many as twelve in number. The web is always made so that the lowest egg cocoon is at the hub. Here the spider hangs from the under side of the web head downwards, with her tail resting on the lowest egg cocoon. These cocoons are oblong in shape, about one centimetre long, made of strong brown thread, and strung together in such a way that the lower end of one cocoon overlaps the upper end of the next, and so on. Each cocoon contains about 46 eggs, which are small, nearly spherical in shape, and of a pale yellow colour.

The males were found in the irregular net-work, which surrounds the circular snare. In several instances two males were present in the one web.

Locality: Punch Bowl Reserve, Launceston.

REFERENCES.

(A) Hogg, Proc. Zool. Soc., 1901, Vol. II., Part I., page 261.

(B) Hogg, Proc. Zool. Soc., 1902, Vol. II., Part I., page 137.

(C) Rainbow, Rec. Austr. Mus., X., 8, 1914, page 239.

(D) Rainbow and Pulleine, Rec. Austr. Mus., XII., 7, 1918, page 160.

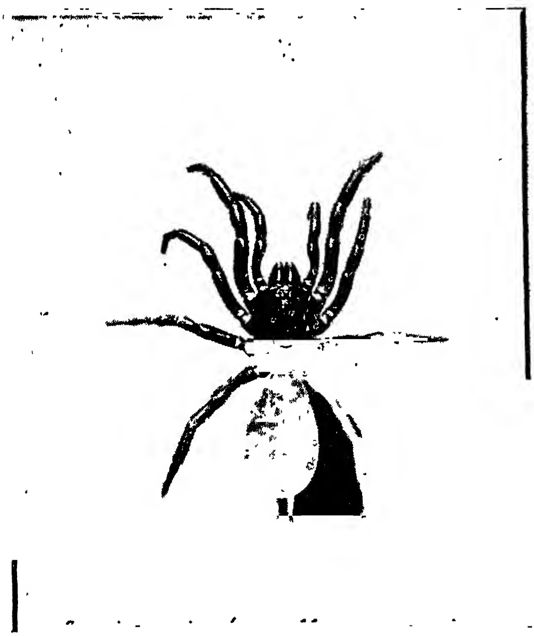
(E) Hogg, Proc. Zool. Soc., 1902, Vol. II., Part I., page 123.

(F) L. Koch, "Die Arachniden Australiens," 1871, page 122.

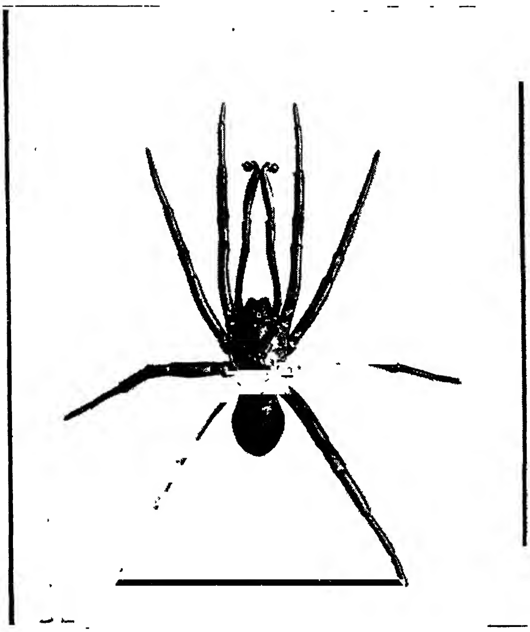
(G) Rainbow, Rec. Austr. Mus., IX., 2, 1911, page 179.

(H) Simon, "Histoire Naturelle des Araignées," 1895, I., page 777.

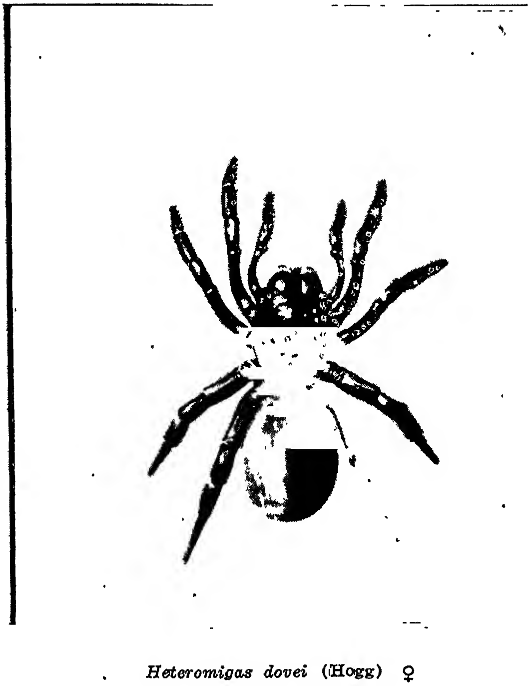
Chenistonia trevallynia ♂ (*sp. nov.*)
(enlarged).



Chenistonia trevallynia ♀ (*sp. nov.*)
(enlarged).



Heteromigas dovei (Hogg) ♂
(enlarged).



Heteromigas dovei (Hogg) ♀
(enlarged).

STUDIES IN TASMANIAN MAMMALS, LIVING AND EXTINCT.

No. XIV.

THE EARED SEALS OF TASMANIA (Part 2).

Arctocephalus tasmanicus, sp. nov.

By

H. H. Scott, Curator of the Launceston Museum,

and

Clive Lord, F.L.S., Director of the Tasmanian Museum.

Plates XVI.-XXI.

(Read 14th December, 1925.)

As pointed out in our last paper (1925, p. 75), the Eared Seals of the Australian coasts have been revised recently by Professor F. Wood-Jones, D.Sc., F.R.S. (1925, p. 9), who lists three species under the genus *Arctocephalus*, namely:—

1. *Arctocephalus cinereus*, Péron.
2. *Arctocephalus doriferus*, Wood-Jones.
3. *Arctocephalus forsteri*, Lesson.

When listing the Tasmanian vertebrates a year or so ago (Lord and Scott, 1924, p. 307) we referred to the Fur Seal of Bass Straits as *Euotaria cinerea*, but whilst referring to and accepting McCoy's data, we drew attention to the need for further research.

These further investigations we have been endeavouring to carry out, and the publication of the paper on the Eared Seals of South Australia (Wood-Jones, 1925) was of considerable assistance, as it dealt fully with the synonymy, etc., of the three above-mentioned species.

As a result of Professor Wood-Jones's visit to Tasmania he was able to see certain of our collections, and also we are indebted to him for an exchange of specimens.

Concerning *Arctocephalus cinereus*, we would point out that this is a large so-called "hair seal" ranging in size from 10 to 12 feet in length for the males, and 8 to 10 feet for the females. As the skull characters are well defined, and the size, as well as the nature of the pelts, marks them out as a specific group, they do not strictly come within the scope of our present paper.

As regards *Arctocephalus doriferus* with its eleven synonymies, we have already stated (1925, p. 78) that it does not agree with the specific characters of the common seal of our coasts, while in point of size they do not agree with the third species, *Arctocephalus forsteri.*

Having examined certain of the skulls of our Tasmanian seals since writing his paper, Professor Wood-Jones agrees with us that they do not fit in with either of the three species of his list, and he has suggested specific distinction, which we propose to give in this paper. Within the last few weeks the Tasmanian Museum was able to secure a series (adult pair and young) of this seal, and our thanks are due to the Police Department for securing the specimens, which have proved of considerable assistance, as the series contains associated skulls and pelts of both sexes as well as the young.

Before dealing with the specific characteristics, however, it may be as well to refer once more to Professor McCoy's descriptions (1879, p. 31, and 1883, p. 71) as given in the Prodromus of the Zoology of Victoria. His splendid notes detail *Euotaria cinerea*, and upon the evidence of Constable G. Ardill he regards this as the only seal found from Philip Island to Wilson's Promontory. Ardill says that the seals inhabit all the islands of Bass Straits, but he evidently knows nothing definite as to their classification. In McCoy's earlier account (1879, Dec. 4, p. 11) it was stated that the species in question had at one time been found in Bass Straits, but was then (1879) exceedingly rare.

Lucas and Le Souef (1909) re-listed *Euotaria cinerea* under the heading of "The Australian Sea Bear" (*Arctocephalus forsteri*) and reproduced McCoy's illustrations and data.

Professor Wood-Jones (1925) includes both the above names as synonymies of his recently-created species *Arctocephalus doriferus*, and, having examined skulls of our Tasmanian seals, notes that their structural departure is specific from the crania of the species described by him.

Under the circumstances we propose in the present instance to describe the specific characters of the common Tasmanian seal and to assign to it the designation *Arctocephalus tasmanicus* (the Tasmanian Fur Seal).

ARCTOCEPHALUS TASMANICUS, SP. NOV.
GENERAL DESCRIPTION.

MALES.

Eight feet six inches when fully grown, a stature that is probably reached at the eighth year, although no super-ossification of the skull will have then taken place. The palatine, zygomatic, and facial sutures will be in strong evidence, and the sagittal crest will be as detailed previously (1925, p. 77) concerning the Scamander skull. The mandibular symphysis will withstand careful maceration, but if an exceptionally well-cleaned jaw is required the rami will part company.

Skin, if tanned, will form mat of the following size:—

Length, including hind feet	8 feet 6 inches
Width of skin	4 feet 3 inches
Length of arm	1 foot 9 inches
Width	1 foot 2 inches
Length of hind limb	1 foot 2 inches
Width of hind limb	6 inches

Nails of hind limb a full inch in length (for the central three), their points being three inches from the ends of the skin flaps, the two outside nails being smaller.

Colour.

Hairs of face and nose greyish, but darker upon the cranium, lighter again upon the neck, although darker than the face. All the back brown, with a hint of grey caused by the lighter tips of the longer hairs. Dark isabelline upon the chest, with light but rich chocolate upon the sides and belly, darker from the pectoral axilla downwards. The haired parts of the arms and feet very dark brown, under full chocolate colour.

In the males at maturity the front limb greatly exceeds the length of the hind limb, but in the females and young they are of even length, whiskers 8 inches long, horn colour at tips, and black at the basal ends. In very old males these whiskers become quite black, and longer and stronger than in early adult life.

FEMALE.

The notes here given were collected from an animal that had just reared its first pup, its age being very close to 4 years, but under rather than over that amount. The total length of the skin is 5 feet 2 inches and 35 inches wide with-

out any skin trimming. The forearm is 12 inches x 4½ inches, and the hind limbs are the same size. The nails are similar to those of the male in the reduction of size consistent with the smaller bulk of the animal—being just an inch in length and 3 inches from the tips of the skin flaps. The whiskers are 7 inches long, and quite black in colour.

Pelt Colour.

The face is lighter than that of the male, and the cranium a dark silver grey, that shades to brown as it crosses the neck. The whole of the dorsal areas are brown, and in the spread skin—with its lighter edges—it might be described as a wide dorsal stripe. Chest isabelline tint, belly rich chocolate which grades by shades of yellowish brown up to the dorsal areas.

The under fur is lighter in colour than that of the male, and agrees with the young in this respect. In an animal at this stage of development, the skull will be quite devoid of a sagittal crest, all sutures will be open, in the face, zygoma, and palate, and the basi-cranial synchrondrosis unankylosed. The mandibular symphysis would not resist maceration.

YOUNG.

The animal here described is the young of the female just passed in review, and therefore the first pup of a young mother. The total length of the skin is 4 feet 5 inches and the width 26 inches. The forearm is 9½ inches long x 4½ inches wide, and the hind limb is of the same size. The nails are about ¾ of an inch long and 2 inches from the tips of the skin flaps.

Colour of Pelt.

Face a very light fawn shade, and this tint is carried on to the throat and chest. All the areas that are rich chocolate in the adults are here several shades lighter. Practically the whole back is a uniform tint of grey-tipped brown shafted hairs, that give grey or brown shades if the hand crosses the pelt. In the winter it is, of course, grey. The rich under-fur is similar to that of the female. The whiskers, which are black, are 7 inches long.

As this animal is assumed to be less than two years old, the following skull notes may be inset here. All cranial and facial sutures open, with evidence of a fronto-parietal fontenel. Mandibular symphysis not ankylosed.

CO-TYPES.

Having thus dealt with three stages, and incidentally both sexes of the seal in question, it will be necessary to now conduct an inquiry into the diagnostic skull characters of the new species, and in this work as no Holotype could be readily selected a series of ten Co-types has been created with four associated skulls, of which five are the property of the Tasmanian Museum and five belong to the Launceston Museum.

The following list gives details concerning the above-mentioned Co-types:—

Arctocephalus tasmanicus.

1. Skull and associated skin. Tasmanian Museum No. D 751. Male. Estimated age 7½ to 8 years. Collected at Councillor Rock, S.E. of Clarke Island, Bass Straits. August, 1925.
2. Skull and associated skin. Tasmanian Museum No. D 752. Female. Estimated age 3½ to 4 years. Councillor Rock, Bass Straits. August, 1925.
3. Skull and associated skin. Tasmanian Museum No. D 753. Young. Councillor Rock, Bass Straits. August, 1925.
4. Skull. Launceston Museum. Male. Estimated age 12 years. Specimen obtained from Cooee, Northern Tasmania.
5. Skull. Launceston Museum. Male. Estimated age 10½ to 11 years. Northern coast of Tasmania.
6. Skull. Tasmanian Museum No. D 737. Male. Estimated age 9½ to 10 years. Two Mile Beach, North Bay, South-Eastern Tasmania.
7. Skull and associated skin. Launceston Museum. Male. Estimated age 8-9 years. Collected at Scamander.
8. Skull. Launceston Museum. Male. Estimated age 5 years. Northern Tasmania (Barren Joey?).
9. Skull. Tasmanian Museum No. D 746. Female. Estimated age 8 years. Bicheno, East Coast, Tasmania.
10. Skull. Launceston Museum. Female. Tamar Heads, Tasmania.

SKULL.

The sagittal crest characters have already been given in our former paper, so we will here begin with the teeth. The dental formula is as follows:—

Incisors $\frac{3 \cdot 3}{3 \cdot 3}$ Canines $\frac{1 \cdot 1}{1 \cdot 1}$ Molars $\frac{6 \cdot 6}{5 \cdot 5}$

All the molar teeth with anterior and posterior cusps (the two important departures from *Euotaria cinerea* of McCoy being the extra pair of mandibular incisors, and the retention of cusps throughout the molar series). The first four teeth of the cheek series, in both males and females, are larger than the fifth and sixth pairs, but in the young skull the second pair are the largest of the series. An interesting variation in the immature skull is to be found in the fact that the large lateral incisors are developed in excess of the true canines, exceeding them in length by 5 mm. In the mandible of the male, the first pair of molars are smaller than the remaining four pairs, the latter being almost even in size. In the female mandible the disproportion between the first molars and the remainder of the series is much less marked, and even less so again in the immature animal.

To assist the busy man in separating skulls of *A. cinereus* of Wood-Jones and the animal described by McCoy and listed as *Euotaria cinerea*, Péron, but now reduced to a synonym of *A. doriferus* by Professor Wood-Jones, we supply the following diagnostic characters.

OUTLINE DETERMINATIVE CHARACTERS.

The skulls of *Arctocephalus tasmanicus* are all furnished with strong, post-orbital molar processes, *even in the very young animals*, and if the skull is turned base upwards, these molar processes will be found curving well into the zygomatic area. These *do not obtain* in the Victorian animal, but are very slightly in evidence in *Arctocephalus cinereus*. McCoy gives the molar tooth line at 58 mm. for a male animal in *A. tasmanicum* (this would vary from 65 mm. to 72 mm. with age and individual developments), and well up to 80 mm. for the molar series of the South Australian seal, *Arctocephalus cinereus*. The nasal bones supply another test, as the following data will show:—

Arctocephalus cinereus—Maxillary moieties pass the posterior ends of the nasals.

Arctocephalus tasmanicus—The nasals pass the maxillary moieties and expand behind them in matured males and females, but only just pass them in young animals.

Arctocephalus doriferus—Nasals nearly reach the maxillary moieties (Wood-Jones).

If the skulls of the above and those of *Arctocephalus forsteri* of New Zealand (and possibly our waters also) be placed upon the measuring table we get as a result these figures:—

Arctocephalus cinereus, condylo-basal length 290 mm. to 300 mm.

Arctocephalus tasmanicus, condylo-basal length 280 mm. to 290 mm.

Arctocephalus doriferus, condylo-basal length 250 mm.

Arctocephalus forsteri, condylo-basal length 230 mm.

The above are for male skulls and of the species *doriferus*. Professor Wood-Jones gives similar sizes for male and female skulls, but this does not obtain in our Tasmanian species, in which the female skulls seldom exceed a condylo-basal length of 240 mm.

The quickest way to separate skulls of *A. tasmanicus* from those of *A. cinereus*, if the anterior parts are mutilated, is to take the supra-orbital processes of the frontals as a guide, as these in *A. cinereus* are nearly 90 mm. across—as against an absolute maximum of 75 mm. in old and heavily ossified skulls of *A. tasmanicus*. In the female skull of our species these processes reach a maximum—in old skulls—of 50 mm. Although we have collected a much larger body of osteological data than that just presented, we cannot at the moment extend the limits of the present paper, but may return to the subject at a future date.

Of the thirty-six synonyms listed by Professor Wood-Jones for the three species of his determination, it is more than likely that some should be accredited to the seal we have just named *Arctocephalus tasmanicus*, but as our aims are practical we can find no accurate description of the animal we are dealing with, and it certainly falls outside the determinations last presented to Australian science, we have decided upon the designation submitted in the present text—namely, *Arctocephalus tasmanicus;* vernacular name, the Tasmanian Fur Seal.

We desire to draw attention to the economic value of the species, as we are convinced that if taken at the proper time

of year and correct stage of growth the pelts would be of considerable value. The economic aspect is well worthy of attention by the Tasmanian authorities concerned, particularly so in view of the attention at present being given to the fur seals by the countries bordering on the Pacific.

LITERATURE CITED.

1879-1883 McCoy, Prodromus Zoo. Vic., Decades IV. and VIII.

1909 Lucas and Le Souef, Animals of Australia.

1924 Lord and Scott, The Vertebrate Animals of Tasmania.

1925 Wood-Jones, Records S. Aust. Mus., Vol. 3, No. 1.

1925 Scott and Lord, Pap. & Proc. Roy. Soc. Tas., p. 75.

EXPLANATION OF PLATES.

Arctocephalus tasmanicus (sp. nov.)

Plate XVI. Co-type 1. Male skull to show teeth. Estimated age 7½ to 8 years. Tasmanian Museum No. D 751. Collected at Councillor Rock, South-east side of Clarke Island, Bass Straits, and about 35 miles from Tasmanian coast.

Plate XVII. Co-type 2. Female skull to show teeth. Estimated age 3½ to 4 years. Tasmanian Museum No. D 752. Collected at Councillor Rock, Bass Straits.

Plate XVIII. Co-type 4. Old male skull showing large malar post-orbital processes. Estimated age 12 years.

Plate XIX. Co-type 4. Basal view of old male skull.

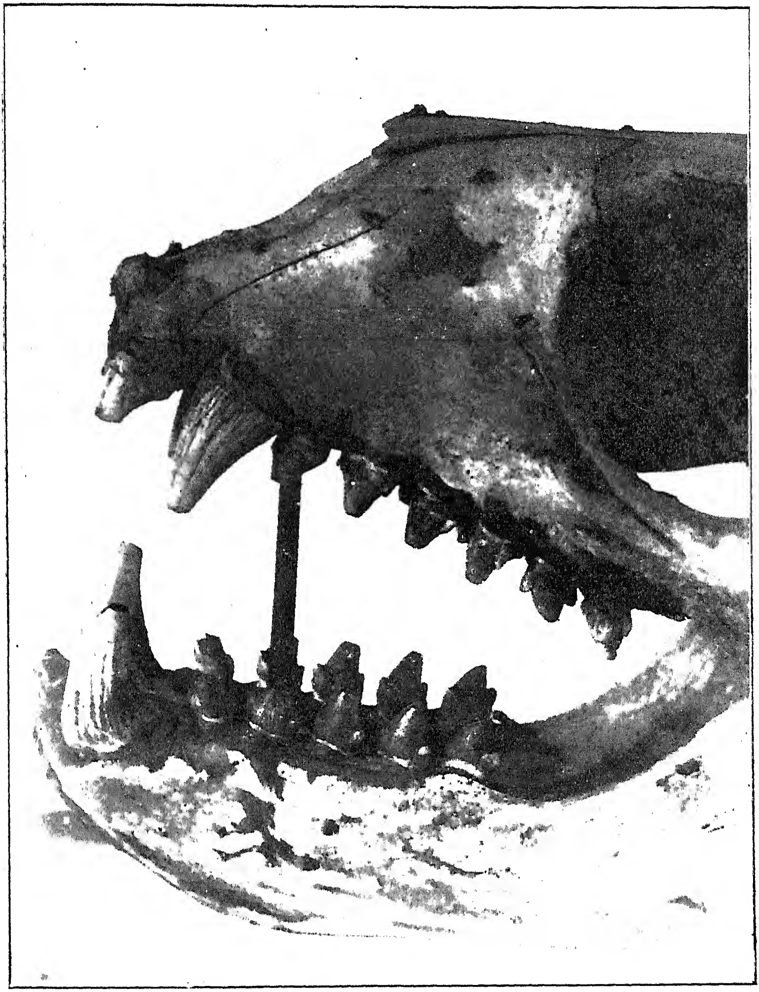
Plate XX. Co-type 9. Female skull showing super-ossification. Estimated age 8 years.

Plate XXI. Co-type 9. Basal view.

ADDENDUM.

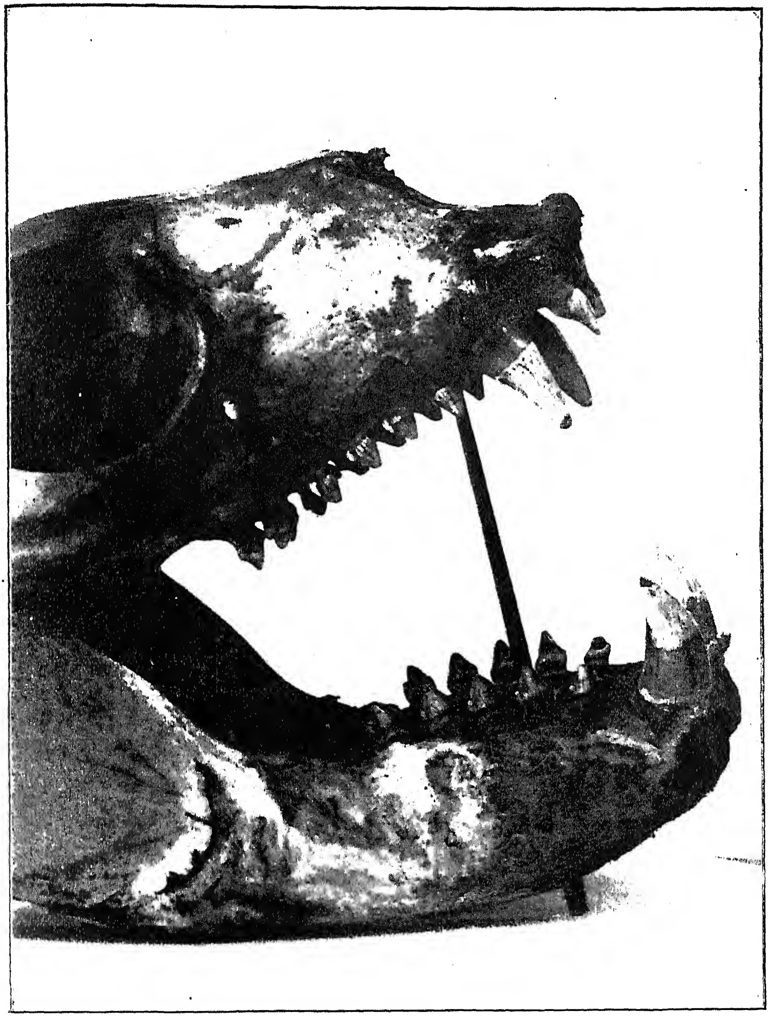
Since writing the above, we have received a copy of Mr. A. S. Le Souef's paper (Aust. Zoologist, Vol. 4, p. 112) which was published on the 10th November last. We fully agree with Mr. Le Souef as regards the economic value of our seals, and there is also the evidence of fishermen and others that there are more than one species of fur seal in Bass Straits.

Arctocephalus forsteri may occur in the Straits, but so far we have not secured specimens, and the common seal of Tasmanian waters is the animal which we have designated *Arctocephalus tasmanicus*.



Arctocephalus tasmanicus (♂).

(Co-type 1.)



Arctocephalus tasmanicus (♀).

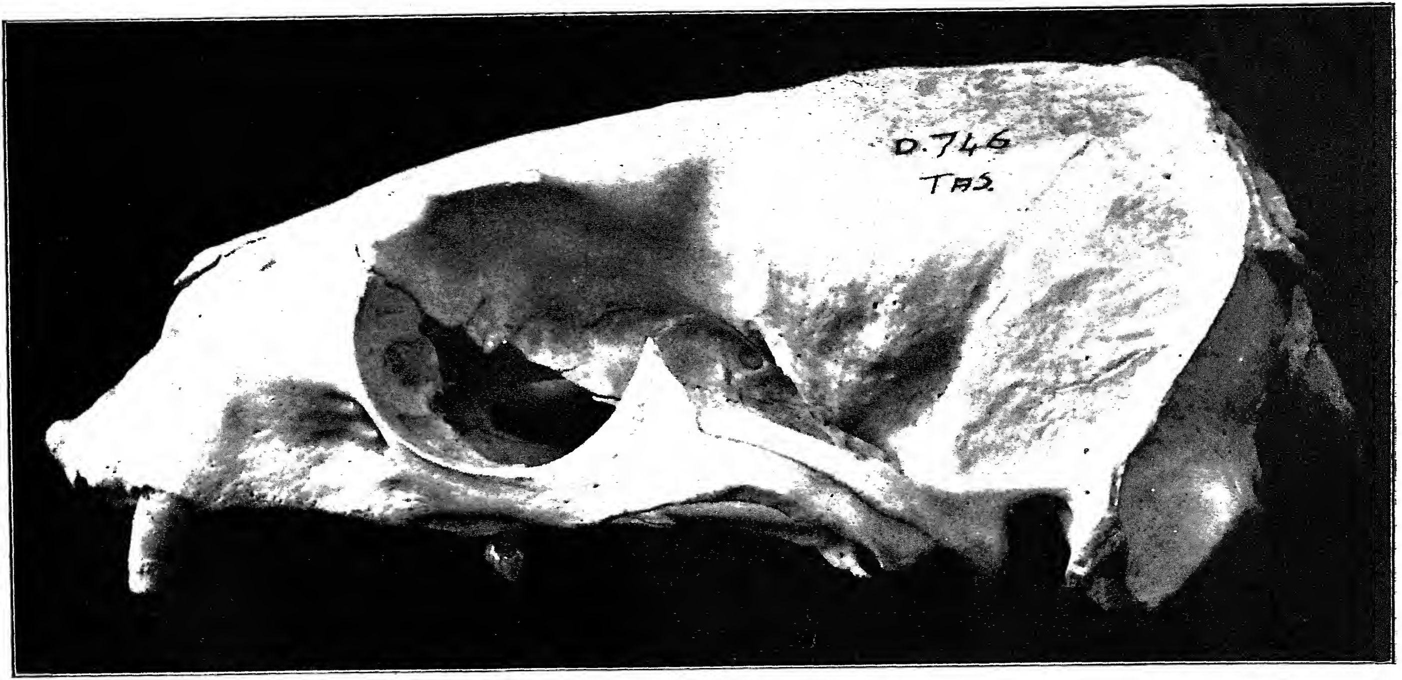
(Co-type 2.)

Arctocephalus tasmanicus (♂).

(Co-type 4.)

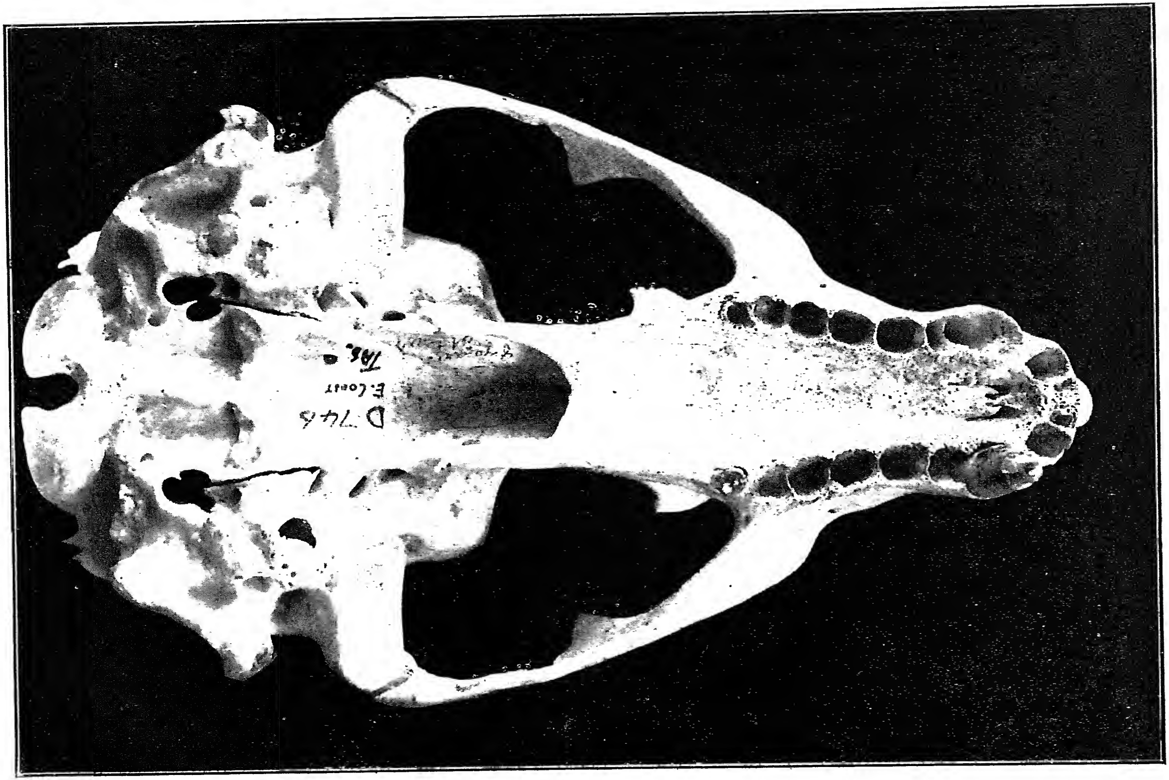
Arctocephalus tasmanicus (♂).

(Co-type 4.)



Arctocephalus tasmanicus (♀).

(Co-type 9.)



Arctocephalus tasmanicus (♀).

(Co-type 9.)

TASMAN'S LANDING PLACE.

By

G. H. Halligan, L.S., F.G.S.,

Late Hydrographer and Supervising Engineer, N. S. Wales Government.

With One Text Figure.

(Read 14th December, 1925.)

According to his Journal, Abel Janszoon Tasman planted his flag and took formal possession of the land, now called Tasmania, on the 3rd of December, 1642.

Unfortunately, the exact position of his anchorage was not fixed by bearings to, or angles between the various headlands, islands, or prominent features in the vicinity, but in other respects the journal is so complete and is so clearly written that the historic spot at which the flag was planted can, I think, be located within a few yards. The matter has already been investigated, mainly through the indefatigable exertions of Mr. Moore-Robinson, Mr. John Kennedy, and Captain Bowerman, who decided that the great navigator had landed at the head of Prince of Wales Bay, an indentation immediately adjoining Cape Lamanon, on Forestier's Peninsula. A very substantial and appropriate monument has been erected at the site chosen, on which the following inscription appears:—

At this spot the expedition under
Abel Jansz Tasman,
being the first white people
to set foot on Tasmanian soil,
planted the Dutch flag
on December 3rd, 1642.

As a memorial to posterity and to the inhabitants of this country
this stone was erected by the Royal Society of Tasmania,
1923.

Some doubts, however, arose amongst certain members of this Society, and a discussion of the matter took place at the rooms on the 17th December, 1923 (see Papers and Proceedings, 1923, p. 166). It was then decided that, in view of the indefinite nature of the evidence, the words of the inscription "At this spot" should be altered to "Near this spot."

During the discussion I expressed the opinion that the landing took place near the south-east corner of North Bay, about 2 miles south-east of the monument, but as I had not visited the site and there might possibly be local objections, such as unfavourable land configuration or the existence of shoal water or foul bottom at the position of anchorage, I have refrained from writing on the subject until I could find time to further investigate.

Owing mainly to my absence from Tasmania, I have only lately been able to examine the locality in detail, and now desire to place before the Members of this Society the result of my inquiry.

To enable us to follow Tasman's movements, I here reproduce copies of his journal of the 1st, 2nd, and 3rd of December, 1642, as edited by J. E. Heeres. The translation has been carefully compared with the original in the Mitchell Library, Sydney.

EXTRACTS FROM TASMAN'S JOURNAL.

Ed. by J. E. Heeres.

1st December, 1642.

"At noon lat. observed 43 deg. 10 min., long. 167 deg. 55 min.; course kept N.N.W., sailed 8 miles (32 Eng. miles), it having fallen a calm; in the afternoon we hoisted the white flag, upon which our friends of the *Zeehaen* came on board of us, with whom we resolved that it would be best and most expedient, wind and weather permitting, to touch at the land the sooner the better; both to get better acquainted with its condition, and to attempt to procure refreshments for our own behalf; all of which may be more amply seen from this day's resolution. We then got a breeze from the eastward and made for the coast to ascertain whether it would afford a fitting anchorage; about 1 hour after sunset we dropped anchor in a good harbour in 22 fathoms (21.65 English fathoms), white and grey fine sand, a naturally drying bottom; for all which it behooves us to thank God Almighty with grateful hearts.

2nd December, 1642.

"Early in the morning we sent out Pilot-Major Jacobsz . . . . , to a bay situated N.W. of us, at upwards of a mile distance (4 Eng. miles), in order to ascertain what facilities (as regards fresh water, refreshments, timber and the like may be available there). About three hours before nightfall the boats came back. . . . . This day we had variable winds from the eastward, but for the greater part of the day a stiff steady breeze from the S.E.

3rd December, 1642.

"We went to the S.E. side of this bay in the same boats as yesterday . . . . . ; here we found water, it is true, but the land is so low lying that the fresh water was made salt and brackish by the surf, while the soil is too rocky to allow of wells being dug; we therefore returned on board and convened the councils of our two ships, with which we have resolved and determined what is set forth *in extenso* in to-day's resolution, to which for briefness sake we refer.

"In the afternoon we went to the S.E. side of this bay in the boats aforesaid, having with us Pilot-Major Francoys Jacobsz, Skipper Gerrit Jansz, Isack Gilsemans, supercargo on board the *Zeehaen*, sub-cargo Abraham Coomans, and our master carpenter, Pieter Jacobsz; we carried with us a pole with the Company's mark carved into it, and a Prince-flag, to be set up there, that those who shall come after us may become aware that we have been here, and have taken possession of the said land as our lawful property. When we had moved about half-way with our boats it began to blow very stiffly, and the sea ran so high that the cock-boat of the *Zeehaen*, in which were seated the Pilot-Major and Mr. Gilsemans, was compelled to pull back to the ships, while we ran on with our pinnace. When we had come close inshore in a small inlet which bore W.S.W. of the ships, the surf ran so high that we could not get near the shore without running the risk of having our pinnace dashed to pieces. We then ordered the carpenter aforesaid to swim to the shore alone, with the pole and flag, and kept by the wind with our pinnace; we made him plant the said pole with the flag at top into the earth at the centre of the bay near four tall trees, easily recognisable, and standing in the form of a crescent, exactly before the one standing lowest . . . . the carpenter aforesaid therefore swam back to the pinnace though the surf . . . . During the whole of the day the wind blew chiefly from the north; in the evening we took the sun's azimuth and found 3 deg. N.E. variation of the compass; at sunset we got a strong gale from the north, which by and by rose to so violent a storm from the N.N.W. that we were compelled to get both our yards in and drop our small bower anchor."

Although not of importance to our present purpose, it is to be regretted that the "day's resolutions" referred to in this journal, which correspond to Minutes of Meetings or conferences held with the Master of the *Zeehaen*, cannot be found.

Tasman was a very wonderful navigator, and was a very observant and careful man, and before all else he was a sailor, and if his journal should appear vague at any particular

point, we must interpet it with this knowledge. He records having dropped anchor, in a good harbour, about an hour after sunset on the 1st of December, 1642. His noon observations show the ship to have been off Cape Frederick Hendrick, and the weather to be calm, but in the afternoon they got a breeze from the eastward, which enabled him to make the anchorage he desired, and for which he was so thankful. If we remember that it was getting on towards nightfall, he was on a totally unknown coast, and he was under sail only and was making for a lee shore, we will naturally conclude that his sailorly instinct would not allow him to go further into North Bay than would ensure safe anchorage. He would be perfectly safe if anchored in the position shown on the chart (see Text Figure), and would have been able to beat out if the wind had suddenly shifted northwardly, as he had every reason to expect. Had he gone further west he would have been embayed, or in a position no sailor would willingly get.

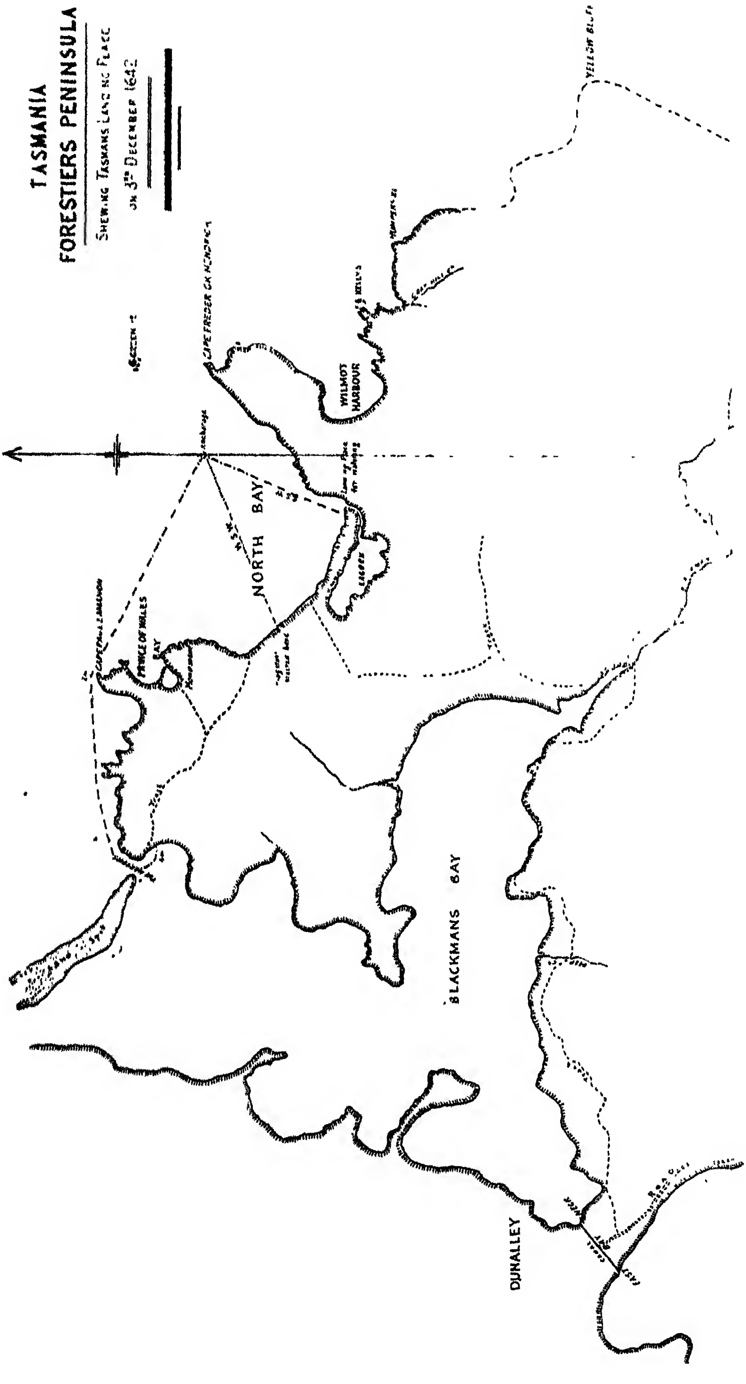
The law of storms was not very well understood in Tasman's day, but it was well known to mariners that the wind in the southern hemisphere always veers from south to north through east, so that Tasman would be on the look-out for easterly, north-easterly, and then northerly winds, which would be one very strong reason for his choosing an anchorage from which he could get away as soon as possible.

On the 2nd of December Tasman sent his Pilot-Major "to a bay situated north-west of us, at upwards of a mile "distance (4 English miles)" to spy out the land, and we find on referring to the Lands Department plan, that the distance from the supposed anchorage to the entrance to Blackman's Bay is just on 4 miles, in a north-westerly direction. It will also be noted that had Tasman been anchored off Prince of Wales Bay, as supposed by Mr. Moore-Robinson, there would be no bay 4 miles to the north-west of him.

On the 2nd of December Tasman records: "This day we "had variable winds from the eastward, but for the greater "part of the day a stiff steady breeze from the south-east."

We now come to the eventful day of the landing, and the journal states:—"We went to the south-east side of this "bay in the same boats as yesterday. . . . . Here we found "water, it is true, but the *land is so low lying* that the fresh "water was made salt and brackish by the surf, while the soil "is too rocky to allow of wells being dug."

At the south-east corner of North Bay the present-day chart shows a creek connecting with a small lagoon about 250 yards from the sandy beach. The water in this creek and in the lagoon is brackish, and the soil on the eastern side is rough and stony, exactly as described in the journal.


TASMANIA
FORESTIERS PENINSULA
Shewing Tasmans Landing Place
on 3rd December 1642
NORTH BAY
BLACKMANS BAY
WILMOT HARBOUR
PRINCE OF WALES BAY
DUNALLEY

The journal continues: "In the afternoon we went to the "south-east side of this bay in the boats aforesaid," and then goes on to describe how one boat had to turn back on account of the rough sea, but the pinnace went on. To quote further from the journal: "When we had come close inshore in a "small inlet which bore west-south-west from the ships, the "surf ran so high that we could not get near the shore without "running the risk of having the pinnace dashed to pieces." This is the small inlet, or creek entrance, before referred to, which bears west-south-west from the assumed anchorage, and as the wind during the day blew chiefly from the north, the locality would be the best that could be chosen by a sailor under the circumstances. It is difficult to understand why Tasman delayed the planting of the flag to the afternoon when the ceremony could have been carried out when he landed at the same spot in the morning to search for water, but the possible explanation is, that the pole "with the Com-"pany's mark carved into it" was not ready. It had, of course, to be prepared and rigged from spare spars carried on board.

As would, I think, naturally be expected, there are no signs of the four large trees referred to in Tasman's journal. These have long ago, by the effects of bush fires and natural decay, been reduced to dust and ashes, and nothing tangible remains to mark the notable spot where the illustrious navigator landed.

On the occasion of my visit to the locality a hard south-west gale was blowing, with blinding rain, so that it was impossible to get to the assumed anchorage in a boat to take soundings. It will be interesting to know if the depth of 22 fathoms (21.62 English fathoms) still exists at the anchorage shown. The exact figures are not, of course, important, as the bottom is "white and grey fine sand," and the depth liable to vary a fathom or two, according to the weather.

Quite apart from the extracts from Tasman's journal and the deductions here given, I have made some calculations to ascertain the time and height of the tide on the date of the landing, with the object of confirming or invalidating the results arrived at.

In order to make these matters quite clear to those members who have not studied the subject very closely, it will be necessary to state, in as few words as possible, some of the elementary facts of the science of chronology.

The Egyptians knew that a year contained between 365 and 366 days, but the Romans did not profit by this information, for Romulus made a year consist of 304 days; this was altered by Numa to one of 355 days—extra months being occasionally intercalated, so that the seasons might recur at

about the same period of the year. This naturally resulted in much confusion in calculating intervals of time, and in 45 B.C. Julius Cæsar decreed that thenceforth the year should contain 365 days, except that in every fourth or leap year one additional day should be introduced. He ordered this rule to come into force on 1st January, 45 B.C.

The Julian Calendar made the year (on the average) contain 365.25 days. The actual value is 365.2422419 days. Hence the Julian year is too long by about 11¼ minutes, and this produces an error of nearly one day in 128 years. This error gradually accumulated, until in the sixteenth century the seasons arrived some ten days earlier than they should have done. In 1582 Pope Gregory XIII. corrected this by omitting ten days from that year (which therefore contained only 355 days), and decreeing that henceforth every year which was a multiple of a century should be or not be a leap year, according as the multiple was or was not divisible by four. The work of framing the new Calendar was entrusted to Clavius, who believed the year to contain 365.2425432 days, but omitted the last three decimals in his assumption of the average length of the year. As we now know the actual value to be 365.2422419 days, there is still an error of one day in about 3,600 years in the Gregorian Calendar.

The change was adopted immediately in all Catholic countries, but more slowly in Protestant. In Scotland the change was made in 1600. In the German Lutheran States it was made in 1700. In England a bill to carry out the reform was introduced in 1584, but was withdrawn after being read a second time; and the change was not effected finally until the 2nd September, 1752, eleven nominal days being then struck out, so that the last day of the "Old Style" being the 2nd, the first day of the "New Style" (the next day) was called the 14th instead of the 3rd. By this it will be seen that the year 1752, in England, contained only 355 days instead of 366 days, it being a leap year. Now a knowledge of this fact is necessary when calculating the time of high water on the East Coast of Tasmania on the 3rd of December, 1642, the date of Tasman's landing.

We know that, at intervals of 18 years and 11 days, the moon returns to the same relative position with regard to the earth, and full and new moon fall on the same day of the month. On the 14th May, 1913, the moon would have been in the same relative position with regard to the earth as it was on the 3rd December, 1642, assuming that no variation in the length of any intermediate year had been made in the interval. There had, however, been a change when the Dutch Government adopted the Gregorian Calendar in the year 1700, when 11 days were taken out of that year to allow for the

accumulated error due to the Julian year being too long by about 11¼ minutes. It was therefore high water at North Bay on the 3rd December, 1642, at the same time as it was on Saturday, the 3rd May, 1913.

From the nautical Almanac we learn that the moon was new on the latter date, and it was therefore high water at North Bay at 8 hours, and low water at about 2 hours 50 minutes, or, say, 10 minutes to 3 in the afternoon of the 3rd December, 1642.

As the moon was in Apogee on the 29th November, was on the Equator on the 2nd December, and the movement of the wind from the 29th November to the 4th December, 1642, indicated a barometer a very little above normal, the tide on the afternoon of the day of Tasman's landing probably fell to within six inches of low water springs level. Under these circumstances it would be very risky, if not impossible, to have crossed the reef at the entrance to Prince of Wales Bay in a pinnace drawing at least twelve inches of water in a strong northerly breeze, and even if the crossing of the reef had been successfully accomplished, the water inside would have been comparatively smooth, and there would have been no necessity for the carpenter to swim ashore to plant the flag.

In any case, it is almost certain that some reference to the reef would have been made in Tasman's journal if it had to be crossed in order to effect a landing.

On the other hand, the journal distinctly states that Tasman went to the south-east side of the bay in which he was anchored, and the carpenter swam ashore and planted the flag near a small inlet which bore west-south-west of the ship. There is no other place except that shown on the accompanying chart, which corresponds to that very lucid and concise description, and the landing could have been effected there as well at one state of the tide as another.

It might also be interesting to state that the 3rd of December, 1642, was a Saturday.

[Note.—For other articles concerning Tasman's landing place, see—

Gell, the Tasmanian Journal, Vol. II., p. 321 (1845).

Walker, Pap. and Proc. Roy. Soc. Tas., 1890, pp. 269-284.

Mault, Report Aust. Assocn. Ad. Sc., 1892, pp. 408-412.

Moore-Robinson, *The Mercury* (Hobart), 22nd January, 1923.

Discussion and Report, Pap. and Proc. Roy. Soc. Tas., 1923, pp. 166 and 180.

Lord, Report Easter Camp Tasmanian Field Naturalists' Club, 1923. Editor.]

AUSTRALIAN FAUNA AND MEDICAL SCIENCE.

By

PROFESSOR WM. COLIN MACKENZIE, M.D., F.R.C.S., F.R.S. (Edin.),

Director National Museum of Australian Zoology.

(Read 14th December, 1925.)

Up till recent times the appeal for the preservation of the unique fauna of our country has been based largely on sentiment. To-day, thanks to poison and the gun, we recognise that many of our animals that were common twenty years ago are becoming increasingly rare, and within a short period of time will have completely disappeared, never to be recalled. In this paper I wish to draw attention to what is now the most urgent plea for the preservation of our fauna, viz., its importance for a correct understanding of the human body in health and disease.

The animals of Australia and Tasmania are teeming with points of scientific interest. Through them human complexities are revealed in their simpler form. Their study is really a study of human embryology, i.e., embryos in which we can study not only structure, but function, on which structure depends—for to the medical scientist the latter must be regarded as the register of the former. So-called "sports," "monsters," and "precocious developments" must have a functional origin and correlations.

NORMAL OR STANDARD TISSUE.

In the consideration of any diseased tissue of the human body, such as cancer, a comparison must be made with the condition in health—the abnormal must be compared with the normal. Thus arises the question, what is normal mammalian tissue? Recognising the effects, over centuries, of alcohol, syphilis, and other poisons on the human race, one would be loth to regard tissues from an individual dying from misadventure or natural causes as typically mammalian, and similarly with animals commonly used for experimentation, such as dogs, rabbits, and guinea-pigs, owing to the modifications of domestication. It is to the primitive mammals of

Australia and Tasmania, unaffected by syphilis, alcohol, or domestication, that have lived in a natural environment for millions of years, that we must look for normal tissue. In the case, e.g., of the ductless glands, the platypus (*Ornithorhynchus anatinus*) offers a remarkable standard for human comparison. Thus the parathyroids are constant, and easily found at the junction of larynx and trachea; Cowper's glands, rarely seen by the medical student, are highly developed; the thymus is retained in the adult; and three ductless glands not so far discovered in us can be demonstrated, viz., parathymus, scapular, and sex glands. In the National Museum the collection of normal histological preparations from reptiles and primitive mammals of Australia and Tasmania, with which human or other mammalian tissue can be compared, is quite unique in the world, and numbers many thousands.

THE HUMAN BRAIN.

To the student of medicine no portion of human anatomy presents such difficulties, whether from the point of view of structure or function, as the brain, and, for the reason that, generally speaking, he knows little about the history of the entities which go to make up the complex central nervous system. When and why does the callosum, the great connecting commissure between the hemispheres, arise? What does the fornix represent? Why is the grey matter external to the white matter? Why should the thalamus be a single body in mammals up to man, in whom the only representation of unification may be but a simple band? What does the free edge in the interior of the brain represent? Is the lateral ventricle of man a similar structure to that of reptiles? These are basic problems in neurology, and can only be answered by a study of the brains of Australian reptiles, monotremes, and marsupials. Our lizards, broadly speaking, can be divided into two main divisions, viz., those moving on their belly wall, such as the blue-tongued variety, using their limbs for bodily propulsion, but not for bodily support; and those, such as the bearded and frilled, that raise themselves off the ground, using their limbs for bodily support as well as bodily propulsion. In the former the olfactory sense is well developed in contrast to the latter with its more extended horizon, the result of an improved muscular effort towards the erect posture. Of the two monotremes, one, the platypus, depends on the streams for its food; while the echidna (*Tachyglossus*) has left the water, is found all over the Commonwealth, and has its body well raised off the

ground, using its limbs definitely for bodily support as well as propulsion. In the former the brain is smooth and unconvoluted, in contrast to the richly convoluted brain of the latter, which reminds one of a miniature human brain. Amongst the marsupials the nearest approach to the brain of higher mammals is found in the kangaroo (*Macropus*), an animal able to adopt an erect attitude owing to the tripod formed by the great tail and the two feet. Its cortex is in marked contrast to the feeble unconvoluted cortex of koala—an arboreal animal. In our mammals the free edge in the interior of the brain—which is not found in that of reptiles—is present, and the grey matter is external to the white; but the characteristic callosum of higher mammals has not yet appeared.

THE GASTRO-INTESTINAL TRACT.

Many arbitrary divisions of the human intestinal tract are described, and, in the case of the large intestine or colon, no less than nine portions are noted. In addition there are two ill-understood areas, viz., the great omentum and the lesser peritoneal sac. It may be stated that no portion of the human abdomen is so puzzling to the anatomical student as these areas. If we examine the lowly stump-tailed lizard (*Trachysaurus rugosus*) or the blue-tongued skink (*Tiliqua scincoides*) we find a simple primitive intestine without development of cæcum, great omentum, or lesser sac. In the bearded lizard (*Amphibolurus barbatus*), using its limbs for propulsion as well as support, although there is a commencement of the hitching up of intestine which reaches its culmination in erect man, together with the genesis of a cæcum and duodenum, there is still no trace of great omentum or lesser sac.

In these reptiles the heart is not yet four-chambered—there is no respiratory piston or diaphragm, and the spleen is miniature in size.

In the platypus the heart is four-chambered, the red blood cell is now non-nucleated, a diaphragm has developed, and the spleen has reached great proportions, spreading itself in the shape of two great processes over the abdominal cavity. This development of spleen has necessitated the development of a mesentery or great omentum on which it is swung, and here in its simplest form we have the development of the lesser peritoneal sac. In our monotremes and marsupials the student can study the method of gut fixation which is such a marked and puzzling feature of the human intestine, and

by studying the intestine of koala (*Phascolarctus cinereus*) or the common phalanger (*Trichosurus vulpecula*) he realises that the nine divisions of the human intestine really consist of but two portions, a right or mesenteric portion swung on the mesentery with the small intestine, and a left or mesocolic swung on the mesocolon.

In the bearded lizard we see the genesis of the cæcum, in the koala its greatest development, and in the wombat (*Phascolomys mitchelli*) we have an appendix resembling the human, but showing usually a more advanced stage of retrogression even up to complete disappearance. It may be mentioned that the minute stomach of platypus and the larger one of echidna show a lining of stratified epithelium, and not of columnar cells. In both the Tasmanian devil (*Sarcophilus*) and the Tasmanian tiger (*Thylacinus*) the intestinal tract presents a simple loop with little apparent distinction between the large and small intestines. No cæcum is present at the junction of these; but a well-defined vagal nerve distribution can be demonstrated. This latter is important in the consideration of the "lock" system of the alimentary canal, to defects of which diseases such as chronic constipation may be due.

THE MUSCULAR SYSTEM.

Of all mammals man is the most intelligent and the most erect.

Other animals, such as the anthropoid ape, monkey, and dog, can assume the erect attitude; but in all these, balance on the two limbs is an effort. There is not that freedom of the fore limbs from support that has given rise to the development of the tactual sense characteristic of the human. Whether viewed from the question of health or disease a correct understanding of the mechanism of the erect posture and its correlations, such as respiratory, circulatory, and intestinal, is essential.

The erect posture is the underlying basis of higher mammalian development, and the great epochs in this development are represented by improvements in muscular function. The erect posture is not an old acquisition, and consequently is easily attacked. To-day, recognising this, medical men are paying more attention to postural defects as the underlying pathological basis of much of the chronic disease seen in our hospitals. Included in our fauna we have animals crawling on their belly wall using their limbs for bodily progression,

not for bodily support; others, such as the platypus, using limbs for bodily support as well as progression. In the echidna we have an animal whose belly wall is definitely off the ground. In koala we find an animal able to raise its hand above its head in reaching for the gum leaf, and in the kangaroo we can study an erect posture achieved by means of a tripod.

Through our fauna also the comparative value of the functions of human muscles can be studied, and it is along these lines that the modern treatment of infantile paralysis has been evolved. We recognise that muscular functions recently acquired as seen, e.g., in connection with the ecto-gluteus of the hip or the quadriceps extensor of the knee, or those disappearing as seen, e.g., in connection with the inverters and everters of the foot, are unstable and readily attacked by disease.

THE GENERATIVE SYSTEM.

Amongst our animals are egg-layers, egg-layers provided with mammary tissue for the nourishment of the young, and others whose young are born in an immature or embryonic state and develop to maturity within a marsupium or pouch. The fact that our marsupials have solved the question of sustained life with embryonic birth is interesting, when we consider that even a seven months' human fœtus is reared with difficulty. The greatest problem in human midwifery to-day is a knowledge of the impetus causing birth. Why should a human fœtus be born after a period of development of nine months, and that of the kangaroo at one month?

By a study of the method of unification of the Mullerian ducts in our marsupials light is thrown on abnormalities met with in the human genital system. Here, too, can be studied the physiological principles of uterine suspension, to correct defaults in which so many gynecological operations are now undertaken.

In the adult male monotreme the testes are still intra-abdominal, and the urinary and genital tracts separate. In the marsupials the prostate gland appears—in fact, in animals such as the phalanger it would appear to have reached its greatest relative development. Here, too, the urethra is genito-urinary and the testes have left the abdomen and are extra-abdominal. Interesting light is thrown on the pathology of hernia (rupture). In the kangaroo, wombat, and koala the internal abdominal ring and sac are patent;

but no instance of hernia has ever been recorded in these animals. In the Tasmanian tiger and devil the internal ring is closed. Nature has "cured" the hernial sac. Why is this necessary in the latter, and not in the former?

CONCLUSION.

This article but touches human problems on which a study of the members of our fauna throws light. The foundation of the National Museum of Australian Zoology by the Federal Government is a recognition of the importance of our native animals to medical science, and of the duty owed to future generations of Australians. But time is a factor; for the fauna is fast disappearing, and every specimen is of importance.

The Federal Capital Commission has now allotted sites for the National Museum at Canberra. That for the museum, laboratories, and lecture theatre is a magnificent one on Acton Hill, not far from Civic Place, and facing Parliament House and the Capitol site. The area is a semicircular one containing five and a half acres. The Research Reservation is a peninsula of about 80 acres, bounded by the River Molonglo, and facing Black Mountain. It lies in what is known as the Continental Arboretum. Here will be kept live specimens of Australian and Tasmanian native animals in their natural state. When the buildings are erected Canberra will become the world's centre for the study of our unique fauna, and every facility will be offered to workers not only Australian, but also from abroad, wishing to study comparative anatomy and its application to modern medical and surgical practice.

Documents, illustrations, and specimens, if sent to the National Museum of Australian Zoology, which is temporarily housed at 612 St. Kilda Road, Melbourne, will be catalogued with the donor's name attached, and will be national property for all time.

NOTES ON THE CURRENCY OF EARLY TASMANIA (1803-25).

By

JOHN REYNOLDS.

Plates XXII. and XXIII.

(Read 14th December, 1925).

SYNOPSIS.

A. INTRODUCTION.

(a) INTRODUCTORY REMARKS.

The economic history of Tasmania has yet to be written. This paper is offered as an introduction to that section of the subject which embraces the currency and the exchange relations of the early colonists. The period covers the years of governmental dependence of Tasmania upon New South Wales. These years stand out distinctly when we

survey the growth of the State. Two reasons sufficiently account for this fact. Firstly, the young Colony was ultimately ruled by the Governors of New South Wales, who, with one exception, were little acquainted with the island's affairs. Secondly, the local Lieut.-Governors were responsible only to their superiors at Sydney, often a fortnight's sail away. Until the closing years of the period, any form of constitutional government was impracticable, and the Lieut.-Governors exercised their wide powers unchecked. Owing to the nature of the Tasmanian settlements the Government entered very largely into the life of the community. As well as exercising all those functions with which we are to-day familiar, it was the chief purchaser of the products of the soil, it sold settlers' requirements, and it regulated conditions of labour at its pleasure. After 1825 this state of affairs rapidly changed as a result of separation from New South Wales, the beginnings of responsible government, and the great influx of free settlers from Great Britain. Owing to the Colony's intimate connection with New South Wales, it is from the history of that State we must seek to gain a clear understanding of many aspects of life in early Tasmania. This is most necessary in the case of the currency.

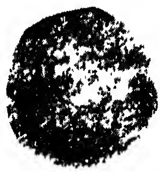
Our knowledge of the first decade of this State's existence is unfortunately very limited; apart from official documents and a few private papers of early settlers, we have no sources of information. The diary of that worldly chaplain, the Rev. Robert Knopwood, provides a certain amount of interesting information, but it is of little assistance for the present study. More records have come down to us from the later years of the period. The *Hobart Town Gazette*, a newspaper under official control, provides us with a useful quarry of facts. The official papers are greater in numbers, and become more informative. The House of Commons, in 1821, sent out a commissioner in the person of J. T. Bigge, to inquire into all branches of administration of the colonies. His inquiries were searching, and his report is invaluable to the student of the times. But the greatest want felt is the private papers and letters of colonists to give us a peep behind the scenes, and enable us to understand what they thought of all the gubernatorial wisdom. No doubt a future generation, by the discovery of some papers now hidden, will be better informed than we are to-day.

(b) The Currency of Early New South Wales (1788-1803).

From the earliest days there was at Sydney a lack of

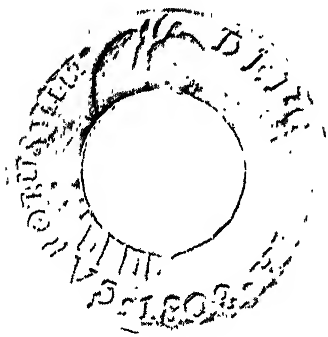
SPANISH DOLLAR.

Obverse.



Reverse.

DUMP DOLLAR.



HOLEY DOLLAR.

British coin, or any other reliable metallic money. The Home Authorities had only sent out a few chests of coin with the First Fleet. This amount they considered ample for a small penal settlement. As early as June, 1789, Phillip found himself unable to pay wages in coin. His request for another remittance of specie was not complied with for over two years. Late in 1792, £2,500 of British silver arrived at Sydney. Nearly ten years were to elapse before another supply of coin was despatched to the Colony. The reason is not hard to find. The British nation was fighting abroad in a death struggle with Revolutionary France. At home, famine and dissatisfaction walked hand in hand. In 1797 the Bank of England suspended gold payments. It is not difficult to understand the unwillingness of Ministers to send coin to a small penal settlement on the Pacific coast of an almost unknown continent.

[Phillip to Nepean, 20/6/1789, 1 (a).]

In New South Wales, matters went from bad to worse. With no export trade there was a continual drain on the scanty supply of coin to pay for imports. The ships which made purchases of supplies left behind them a great assortment of coins, the currencies of many nationalities being represented. The shortage of coin and general conditions produced a state of affairs that had been experienced in the American colonies, particularly Massachusetts, a century before. The official receipts given by the Government Stores for produce passed immediately into circulation. They were really official promissory notes. Private promissory notes were also issued in great numbers, and became a menace to credit. Spirits bearing the general designation of rum entered into colonial life to an almost incredible degree; a gallon of rum became an accepted value, which even the authorities were forced to recognise.

In 1800, Philip Gidley King became Governor of New South Wales. Despite difficulties arising from the insubordination of the New South Wales Corps, his only military force, and an Irish insurrection, he made great efforts to place the currency on a satisfactory basis. He drew up a table of specie which contained the values at which the various foreign coins then circulating would be recognised. In this list, with the British coins are found the Dutch Guelder,

NOTE 1.—The numbers refer to the source of reference, see Bibliography.
Letters in brackets refer to the volumes of the Historical Records of Australia.

the Spanish Dollar, the Venetian Ducat, the Portuguese Joana, and the East Indian Rupee. King suggested that a special coinage be made for the Colony, and he cut down the Spanish dollar to provide small change. These efforts met with no success, but he did succeed in inducing the British Government to send out £2,500 worth of copper pennies, which he ordered to circulate at twice their nominal value.

[Table of specie, 19th Nov., 1800. 1 (c), p. 39. King to Hobart, 20th Dec., 1804. 1 (c), p. 206.]

Another serious matter was forcing itself upon King. The presence in Australian waters of a French expedition, ostensibly engaged in scientific research, the unoccupied island of Tasmania, and the disquieting rumours of French colonial aspirations caused him grave concern. He resolved upon immediate action. Under his direction two parties were despatched to form settlements in Tasmania. The first party, commanded by Lieut. Bowen, was sent to the Derwent, the other, under the command of Colonel Paterson, went to Port Dalrymple, on the northern coast. Between the arrival of these small parties, an expedition despatched by the Home Authorities arrived at the Derwent. This expedition was commanded by Lieut.-Colonel David Collins, who had previous experience in New South Wales, and was a man in every way suited for the task of founding a new colony. Bowen's party achieved practically nothing beyond occupation. Paterson was more successful, but Collins started the real work of colonisation.

The records which are of use in the present study refer almost entirely to the settlements which were under the guidance of him and his successors.

B. THE TASMANIAN CURRENCY.

(a) Coinage.

(i) The Early Years, 1803-13.

From our meagre information there is no evidence to show that either Bowen, Collins, or Paterson brought any coin with them to Tasmania. However, we do know that before Collins had been six months at Sullivan's Cove he was unable to pay official salaries in coin. His predicament was similar to that of Phillip at Sydney, sixteen years before. (See Section A.) The immediate liabilities of the Government he met by an issue of official promissory notes, hoping to receive a supply of coin from Sydney. However, it was useless to expect help from that quarter. The passage of

time had not mitigated Governor King's difficulties. After the insubordination of the New South Wales Corps, the currency was among his worst worries. In his despatches to the British Ministers, he vividly describes the evils arising from the scarcity of coin. The few persons who possess Spanish dollars, he tells the Earl of Camden, engage in a usurious and ruinous traffic in spirits. His ill-fated successor, Bligh, was less fortunate. Dollars, he informs Windham, are hoarded for sinister purposes. In such circumstances it is not difficult to understand that the Tasmanian settlements in all probability received no remittance of coin from New South Wales during these years.

[Collins to Sullivan, 3rd Aug., 1804. 1 (l.) p. 261. King to Camden, 1805. 1 (c), p. 671. Bligh to Windham, 1807. 1 (f), p. 156.]

(ii) The Colonial Coinage (1813).

A new era commenced when Colonel Lachlan Macquarie became Governor-in-Chief of the Australian Colonies late in 1809. With characteristic energy he applied himself to settling the currency troubles once and for all. However, he soon found that with all his veering and tacking he was only following the course of his predecessors. His despatches to Lord Castlereagh on the subject were couched in strong terms, but still he failed to get a remittance of specie for some years. Fortunately for the colonies, and the Governor's peace of mind, the British Government at last, after nearly twenty years, sent another supply of coin to Australia.

[Macquarie to Castlereagh, 1810. 1 (g), p. 242.]

By an arrangement with the Directors of the East India Company, in 1812, £10,000 worth of Spanish dollars were shipped to Sydney.

It may appear strange that the British Government should issue Spanish coin for circulation within its own dominions; but the Spanish dollar was then almost a universal coin, and was already well known in Australia.

Macquarie held strong and often very original views upon finance and economy. In order to prevent the new dollars' inevitable disappearance by export, he took a curious measure. A circular piece measuring 11/16ths of an inch was struck out of each dollar. The remaining ring was stamped with the words "five shillings" on the obverse, and "New South Wales" on the reverse. The disc that had been struck out was also subjected to the following impressions:—

Obverse—A crown in centre; New South Wales above, 1813 below. Reverse—Fifteen pence in two lines. The edge being roughly milled with dies.

[Proclamation re issue of Holey and Dump dollars, 1813. 1 (a), p. 750-6. Also Chitty, 26.]

The first coin, the Holey or Ring dollar, was issued at the value of the original coin, five shillings. The centre piece, or Dump, became officially valued at fifteen pence. Thus the dollar was enhanced in value to the extent of 25 per cent. So by a few simple operations, Macquarie gave the Colony a currency which had at least some useful properties. The proclamation which announced the issue of what may be called the Colonial coinage, imposed severe penalties for clipping or otherwise mutilating these coins. Seven years' confinement, within the beneficent precincts of a Colonial prison, seems to have successfully overcome the temptation to clip an occasional handful of dollars, in Tasmania, at any rate.

Colonel Thomas Davey was now in command of the settlements of the island. His four years' administration is chiefly remembered from the prevalence of bushranging, and other lawlessness. Nevertheless, the Colony progressed. All food supplies were now locally produced, and the days of famine and dependence on New South Wales had passed away. Strangely enough, in all the correspondence between Macquarie and Davey, no reference can be found relating to a remittance of the Colonial coinage to Tasmania. It certainly circulated in the island, and if the reports of persons still living may be credited, it lingered in use late in the 'forties, long after its official withdrawal. Even to-day an occasional Dump is found in old houses. As the proclamation ordering withdrawal from issue was published in the *Hobart Town Gazette*, it is certain that it circulated in Tasmania.

West and Fenton, in their histories of Tasmania, mention the Colonial coinage, but they both state it was issued in the year 1810. We can positively assert that no such coins were issued before 1813. It is probable they were not as well informed about the matter as we are to-day.

[West (13), p. 76. Fenton (14), p. 54.]

Samuel Mossman, in his work *Our Australian Colonies*, says that in Tasmania, pieces the size of a shilling, at which value they circulated, were cut from the Spanish dollar. The ring left circulated at four shillings. Further, he says, that this money was scarce, being issued from the Government

Stores to the Contractors in provisions who held a monopoly, very little actually passing into circulation. From this it would appear that a separate coinage was issued in Tasmania. Absolutely no evidence can be found to support these statements. In a letter to the writer, Mr. Alfred Chitty, the well-known Australian numismatist, says:—

> "As these two coins have never been met with, numis-
> "matists consider that Mossman is in error, and that he
> "is confusing them with the Holey and Dump dollar.
> "For all that, there might be two such coins struck in
> "Hobart; if they could be found, they would be a prize.
> "Some of the dollars were freely stamped with the head
> "of George III., and many reached Australia and were
> "cut down. One thing I am pretty certain about is
> "that some half and quarter dollars were stamped with
> "the King's head in Tasmania."

[Mossman (15), p. 142.]

It seems possible the authorities at Hobart or Launceston stamped some dollars to suit their convenience. For ten years the Colonial coinage remained in circulation, and it appears to have been, and probably was, a benefit to the colonists.

In 1816, a small quantity of copper coin (£105 worth) was sent by Governor Macquarie to Tasmania, to supply the want of small change. Next year the enhanced value of copper coin, which had been unchanged since 1801, was reduced to its face value.

[From Summary of letters to Asst. Commissary General, Hobart, from Sydney, 28/6/1816. 1 (m), p. 605.]

Colonel William Sorell, who became Lieut.-Governor of Tasmania in 1817, carried into effect a policy which added materially to the prosperity of the Colony. He restored order, stimulated wheat growing, laid the foundations of the wool industry, and organised public finances. His administration left a lasting impression on the Colony.

The scarcity of specie was still an annoyance in small transactions, and an obstruction in the larger business relations of the colonists. It appears that Sorell made the best of the position, working as well as possible with the small supplies of coin in circulation. He constantly endeavoured to keep all official values expressed in sterling, despite the fact that the Spanish dollar was the commonest coin. The official notices in the *Hobart Town Gazette* are a contrast to the

private notices, advertisements, sales, and offers of reward. In the latter cases, when coin is mentioned at all, it is most often expressed in dollars.

(iii) Brisbane's Reforms.

More troubles lay ahead for those in authority in New South Wales and Tasmania. For twenty years, through the exigencies of the French Wars, the Bank of England had suspended gold payments. These were resumed in 1817, and had the effect of lowering the value of the Spanish dollar. The depreciation in England was considerable, the value falling to 4s. 2d., whilst in New South Wales and Tasmania, the dollar still circulated at five shillings. Hence it became extremely profitable to ship dollars to New South Wales. And this was what actually happened. Coghlan states that in 1822 two ships alone brought 80,000 dollars to Sydney. Goodwin, who wrote a little guide book for intending emigrants to Tasmania, very rightly advises them to invest in dollars before leaving England. Such a state of things could not continue, and Sir Thomas Brisbane, who succeeded Macquarie in 1822, resolved to settle the question at once by the quickest method possible, regardless of any hardship that might then result.

[Coghlan (22), p. 257. Goodwin (8), p. 37. Curr (7), p. 5.]

Brisbane held two views regarding the currency of the colonies. Firstly, that the Spanish dollar, and not sterling, was the best medium of exchange. Secondly, that the value of the dollar must be reduced (in terms of the British pound), and the colonists must bear the burden of this devaluation. He immediately set to work to put these views into practice. The steps taken were drastic, and the immediate results caused much hardship in New South Wales and Tasmania. Merchants found that they now had to pay nearly five dollars to the pound, where formerly they paid four, when purchasing Treasury Bills for remittance to their London Agents and creditors. The settlers that season discovered that the Government Stores only paid them for their crops in dollars at 4s. 2d., in place of the customary five shillings. As many had obtained credit, often at high rates, right up to the full value of their crops at the old rate, great suffering was caused. In the elder colony, Brisbane's policy was met with strenuous opposition from the Directors of the Bank of New South Wales, who championed the colonists' cause. A bitter controversy was waged. The

Secretary of State for the Colonies, the Earl of Bathurst, was appealed to by the Directors, but in vain, Brisbane's actions being generally upheld.

[Coghlan (22), p. 258-66. Memorial of Bank of N.S.W. to Brisbane. 1, (j), p. 730-2.]

In Tasmania, the results of these changes were disastrous to Sorell's careful administration, and caused considerable suffering. We are fortunately well informed of these events, as Sorell gave a very full account of them in a report he wrote to his successor, Colonel George Arthur, on leaving office in 1824. On the 31st May, 1822, Sorell says that the value of the Spanish dollar was suddenly reduced about 20 per cent. It is not difficult to imagine the hardship caused to the many new Tasmanian settlers by this sudden reduction in the value of their crops and other produce. On 27th June, sterling ceased to be the official coinage, and from that date all accounts were to be kept in dollars. Whether this order was entirely put into force is not at all clear. On 15th October of the same year, Sorell issued a General Order, fixing wages, all in sterling, dollars not being mentioned. Neither is it at all clear as to what had happened to Macquarie's Holey and Dump dollars of 1813. Official papers make no mention of their existence after 1814. The next fact known is that Brisbane declared the official value of the Holey dollar to be 2s. 9d., that is slightly more than half its 1813 value. Early in the next year, 1823, Government dues and salaries were paid in dollars. The dollar, it would seem, had become the current coin of the colonies. It is not known whether the confusion resulting from the Government in New South Wales being forced to recognise several values for the dollar existed in Tasmania. Coghlan states that in the Mother Colony the Commissariat paid for its supplies in dollars at 5s., the civil officers were paid in dollars at 4s. 4d., and the military in dollars at 4s. 8d. Certainly the introduction of dollars must have greatly complicated book-keeping. The writer has seen account books of the period ruled with two sets of figure columns, one for sterling, the other for dollars.

Sorell's remarks to Arthur on the reforms of the two preceding years furnish us with a contemporary view of the position. He says:—

"Upon the subject of the Exchange, I confess I did "not consider the Dollar System in itself alone a subject "of complaint, though it might even be a question how

"far it was applicable to these Colonies, and how far they "could yet bear it, for it exists in most, if not all, the "British Colonies, and I believe upon the Same Prin-"ciples. It is, however, to be considered that other "Colonies have an established and Native Commerce, and "that these young colonies, affording yet but little in the "way of export, must consequently discharge a large "portion of their obligations and expenses in money remit-"tance, the means of doing which must depend mainly "on their agriculture and the fostering encouragement of "the Mother Country. But the treble operation of the "Exchange, the reduction of prices, and the termination "of the relations between the Government and the "Grower, and the diminution of the quantity purchased, "is attended by other effects, resulting from the present "State of the Currency."

The clamour against the dollar system and subsequent events evidently made the British Government pay more attention to the New South Wales currency. A large amount of British coin was sent out, and many of the old troubles disappeared.

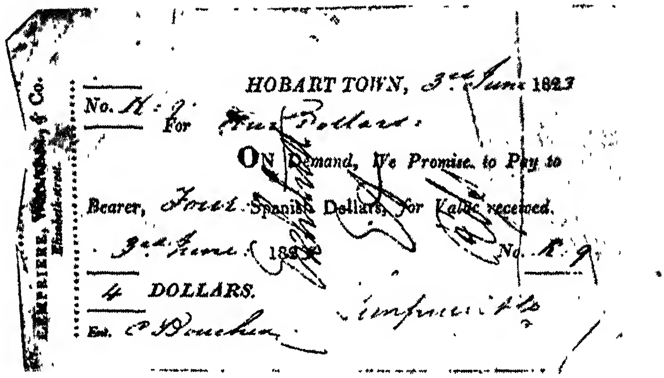
The story had not such a happy ending in the case of Tasmania for many years. In 1826, a year later than the end of the period covered by this paper, an article appeared in the *Colonial Times* (6th October, 1826), in which the writer deplores the lack of specie owing to exportation. He sighs for the good old days of Holey Dollars and Dumps.

[*Colonial Times* (11).]

(iv) McIntosh-Degraves Tokens.

The lack of metallic money induced two enterprising immigrants to bring a small quantity of silver shilling tokens with them from England. This token, originally issued by the firm McIntosh and Degraves, sawmillers, Cascades, Hobart, passed into circulation in 1823. It was the first token to be issued in Australia, and specimens are now highly prized by coin collectors. The actual number of these tokens that was issued is unknown, but it is considered that their value did not exceed £100.

We must now pass on and view the expedients that Colonists were driven to employ through the inadequate supply of coin during these days.


HOBART TOWN, 1823

No. For Dollars.

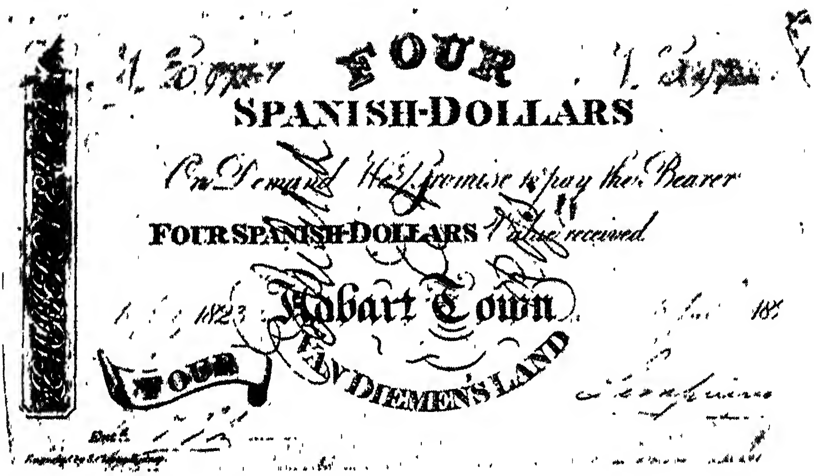
ON Demand, We Promise to Pay to Bearer, Spanish Dollars, for Value received.

No.

4 DOLLARS.

Ent.

LEMPRIERE, & Co. Elizabeth-street.


FOUR

SPANISH-DOLLARS

On Demand We promise to pay the Bearer

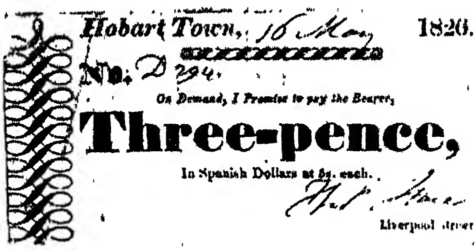
FOUR SPANISH-DOLLARS Value received.

1823 Hobart Town

VAN DIEMENS LAND

FOUR

Ent.


Hobart Town, 1820.

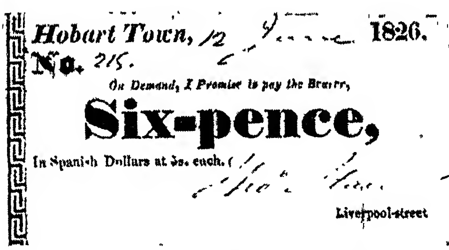
No. D 294.

On Demand, I Promise to pay the Bearer,

Three-pence,

In Spanish Dollars at 5s. each.

Liverpool street


Hobart Town, 1826.

No. 215.

On Demand, I Promise to pay the Bearer,

Six-pence,

In Spanish Dollars at 5s. each.

Liverpool-street

PRIVATE PROMISSORY NOTES.

(b) Paper Money.

(i) Official Notes.

The issue of official promissory notes by Collins has already been mentioned. The circumstances which forced him to adopt that course are easily understood from a despatch he wrote to his official superiors in England:—

> "For the want of specie in the colony to pay the "superintendents and overseers their respective salaries, "by means of which they found themselves unable to "purchase several articles of use and comfort which had "been brought hither in vessels from Sydney, I have "directed the Commissary to issue small Promissory "Notes, not less than £1 sterling in value, which have "proved a great accommodation to these people."

[Collins to Sullivan, 3rd Aug., 1804. 1 (1), p. 261. King to Collins, 30th Sept., 1804. 1 (1), p. 284.]

Only £615 worth of these Colonial Notes were issued, the shipmasters then lying in the Derwent receiving them in payment for the sales of goods they had effected. These notes were then consolidated with Treasury Bills on presentation. Governor King, at Sydney, quite approved of the course taken by Collins in this instance. But King had learnt from bitter experience to appreciate the abilities of the note forgers at Sydney. He particularly enjoined Collins to keep the issue within the limits of Tasmania. "I am "sorry," says King, "means are now used here to counterfeit "them, which may lead to a complicated and extensive evil." When we remember the privations endured by the first settlers, the truth of Collins's remarks concerning these notes becomes apparent. "They would greatly tend," he says, "towards smoothing difficulties that must ever present them-"selves in the Infancy of a distant settlement like this."

[Collins to Hobart, 20th Feb., 1805. 1 (1), p. 305.]

The earliest attempts to raise crops gave the most discouraging results. The settlers were in many cases inexperienced in any form of agriculture, their labour was inefficient, and their implements often faulty. Years had to pass before they understood the climatic conditions and the specific properties of the soil. When a settler succeeded in harvesting a crop, he took it to the Government Stores at Hobart or Launceston. As he could not be paid in coin, he received a receipt on which was stated the quantity of wheat he had sold, and the amount the Government owed him. This sum

the authorities undertook to pay on presentation of the receipt in the near future, generally three months hence. Now the settler had debts to pay, and other business to transact with the town merchants and traders. Unless he had enough money in coin, which was very unlikely, he was forced to make these little adjustments with his Stores Receipts. Naturally enough, the receipts accumulated in the hands of the importing merchants, who presented them at the Government Stores when the time for consolidation fell due. The merchants received drafts on the British Treasury for their bundles of receipts, which enabled them to pay their London agents for the goods sent out on their account.

In a colony where good coin was scarce, and bad paper abundant, these Stores Receipts formed a most important part of the currency. But it was essential that the authorities entrusted with their issue should be careful in their methods, and keep their eyes continually on the watch for forgeries. There were, during the period, one or two instances of fraud on the part of officials. Nevertheless, when Commissioner Bigge issued his report, pleasing facts became known. It transpired that one official, who had been responsible for some years for issuing Stores Receipts, passed £180,000 worth through his hands, and had not seen one forgery. The chief trouble, the authorities found, was getting the holders to present the receipts they held at the right time, when they were due, not six months after that date.

[Bigge's Report, 3. Account of Bigge's examination, see 1 (n).]

Below is a copy of the form of Stores Receipts issued in 1820.

December, 1820.

£0 0s. 0d. Sterling. Hobart Town.

No.

I promise to pay................or Order, the Sum of................Pounds................ Shillings and..............pence sterling for.... Bushels of Wheat delivered by him into His Majesty's Stores at this place, at the rate of ....per bushel.

Per

G. Hull.

To be brought in for consolidation on the 25th.

NOTE 2.—The word consolidation was used in reference firstly to the redemption of official promissory notes, passing then into general use. It appears to have originated from its use in public finance in the eighteenth century, e.g., Consolidated Fund, both in Great Britain and America.

To a much less extent the Military and Police Departments, who arranged their own Commissariat, issued receipts in a similar manner to the Government Stores. These notes likewise passed into circulation.

Hobart Town,
24th April, 1822.

No. 122.

I promise to pay bearer the sum of One Pound Sterling for subsistence of the 73rd Regiment.

(Sgd.) MAJOR GEILS.

(ii) Private Promissory Notes.

Where the Government had shown the way, the colonists were not slow to follow. As in New South Wales, persons of all degrees of wealth issued their own promissory notes. The value of these notes depended, of course, on the ability and the willingness of the persons who issued them to honour them on demand. Notes of all values from pounds to pence were current. Such values as 5s. 8d., 7s. 10d., 9s. 6d., and 15s. 2d. are characteristic examples. To-day it would appear decidedly humorous for a Hobart citizen to give a note promising to pay threepence in Spanish dollars at five shillings. Obviously many notes were merely artifices to obtain credit. The crudity of a great number of notes left their issuers exposed to all the acts of the fraudulently inclined. Still, the colonist of that day dare not be over-fastidious in rejecting the note of a neighbour, for retaliation might some day be highly embarrassing. West in his history of Tasmania gives us a good idea of this part of the currency:—

> "The credit of these notes depended largely on the "Naval Officer; a sort of collector; if admitted in the "payment of duties they were current everywhere."

[Hyman (25), p. 38. West (13), p. 76.]

The writer has not seen any specimens of notes bearing a date earlier than 1810. They were certainly issued before that year, as in the General Orders for 2nd February, 1808, appears Bligh's proclamation commanding all persons to affix sterling values on their notes.

[General Orders, 1808. 1 (1), p. 561.]

Merchants and tradesmen with a high standing in the community issued notes which had been prepared with a certain amount of engraver's skill, making forgery difficult. The notes of Lempriere & Co. furnish an example. There is a striking contrast in the elegant notes of this firm to many of the miserable rags that passed in circulation. Sorell in his report to his successor in office, Arthur, to which reference has already been made, stated:—

> "A spurious paper currency here has tended "materially to aggravate the pressure. Some few re-"sponsible houses had issued paper greatly to the public "convenience and advantage; but numerous speculators "followed till the usual consequences ensued, inability in "many cases to pay."

A little insight into the manner in which business was carried on is revealed by an advertisement in the *Hobart Town Gazette*, 4th January, 1817.

> GENERAL GOODS—Richard Lewis.
>
> Prompt payments to be made in Mr. Hogan's Notes, Stores Receipts, Police Fund Bills, Captain Nairn's, Mr. E. Lord's, Mr. Abbott's, Mr. Gatehouse's, or Mr. Ingles' Notes or good wheat at Stores Price.

(c) PRIMITIVE METHODS OF EXCHANGE.

(i) Barter with Produce.

A settler coming to town with a bullock waggon of wheat generally wanted to get his business done as quickly as possible. He may have become impatient by the endless haggling with the buyer of his produce over the doubtful value of the promissory notes offered in payment. For this man, custom provided a swifter method for settling his business. It was quite usual from the earliest days for wheat and other produce to be exchanged for goods. Again, if Hull's authority is to be accepted, the Government led the way in 1808, by allowing settlers to pay their debts to the Crown in wheat. During the span of two decades for which the Dependency Period lasted, the transaction of business by means of barter was an every-day occurrence. It is

the one fact upon which all authorities agree. Persons at either end of the scale of wealth resorted to this method of satisfying their wants. Numerous examples can be cited. The two below are taken from that invaluable source of information, the *Hobart Town Gazette*:—

> August 10th, 1816.
>
> To be sold at the Warehouse of Mr. Lord, Macquarie-street—7 casks of Virginia Leaf Tobacco, 3 years' credit will be given. Payment to be made in Wheat or Meat at the Storehouse Price.

In the same year, 16th November, wheaten bread is advertised at ten pence for a four-pound loaf, or four pounds of wheat taken in payment. Later in the period, the next advertisements are characteristic of those which appeared in almost every issue of the paper.

> August 6th, 1824.
>
> FOR SALE—Wrought Iron Hurdles. Sheep, Cattle, or Wheat will be taken in exchange.

On 13th August, 1825, Mr. Thomas Atkinson, of Campbell Street, Hobart, offers, amongst other goods, tea, per ship *Phœnix*—"For which," he says, "Wheat, barley, oats, wool, "or any other Colonial produce will be taken in payment."

There is a doubtful story which has appeared in print that the first cargo of Tasmanian wool exported was sold in exchange for merchandise to the skipper of a British Ship at Hobart, in 1819. As Sorell, who took particular interest in the wool industry, makes no mention of it in his papers, the story cannot be accepted. No doubt, however, large quantities of provisions were sold to ships in port in exchange for settlers' requirements. The widespread practice of barter of goods in the Colony helps us to realise how totally inadequate was the supply of coin, and how unreliable were the paper substitutes. Before leaving the subject, it will be of interest to briefly touch on one of the results brought about by this state of affairs.

(ii) The Rum Currency.

Naturally enough an article which was at once easily recognisable, readily transported, and in universal demand

attained almost the dignity of currency, and spirits bearing the general designation of rum came to play this important part in Colonial life. This statement is not the outcome of magnifying small isolated facts. The rum currency existed in Tasmania well on into Sorell's days (1817-24), but it does not seem to have reached the proportions it did in New South Wales. In the Mother Colony, Hunter, King, and Bligh used every means in their power to suppress it, but with little success. Macquarie found himself forced to recognise it in the payment of wages.

Collins found that by paying part of the wages of his workmen in rum, the community was got under shelter far more quickly than it would have been otherwise. Davey, his successor, did not appear to be impressed with the evils arising from the rum currency. However, in a despatch to the Earl of Bathurst, he bitterly complains of the effects of Rum Monopoly granted to a group of Sydney Speculators by Macquarie. He points out that, owing to the right of importing spirits into the Colonies being given to three persons, the revenue of Tasmania, which was largely derived from the duties on spirits, fell considerably. The justice of the complaint cannot be discussed here, but it shows the importance of rum on affairs of administration.

[Davey to Bathurst, 30th April, 1816. 1 (m), p. 147.]

Sorell gave no encouragement to the use of spirits for making payments. In the General Orders for 17th November, 1821, he reminds colonists of a Proclamation given by the Governor-in-Chief in 1815, absolutely prohibiting the barter of spirits, and particularly their use in paying wages. In this Order, Sorell declares it "a practice pregnant with in-"jurious effects, and known to have increased of late in the "country districts." He proceeds, "His Honour feels it his "duty, at this time, to caution all persons for selling, paying, "or bartering with spirits that they are alike subject to the "law, which imposes a penalty on such retailing of spirits, "and it is the determination of the Magistracy to enforce the "law in every case brought before them after December 31st, "1821."

[*H. T. Gazette*, 17th Nov., 1821.]

It can hardly be expected that goods would be advertised for sale with spirits demanded in payment, but that rum was offered for rewards, if we are to believe a writer in

the *Gazette*, and was used in part payment for a wife, is shown by the following:—

"1 Bottle of Rum.

"Strayed on Thursday night, late, from the premises "of Mr. Kennedy, in Collins Street, a small kangaroo. "Whoever may find same, and bring it to its owner at "Mr. Kennedy's, will receive the above-named."

"Some time ago, an inhabitant of this settlement "sold his wife to another for 50 ewes, within a few days "another husband, bent on raising the wind, brought his "spouse to market, but the sale being dull only procured "for him £5 and a gallon of rum."

The writer cannot vouch for the reliability of this report.

On 3rd December, 1825, the Government of Tasmania was separated from New South Wales. Development during the dependency period had been rapid. From the little community of 400 people, who landed with Collins in 1804, in the wooded cove on the west shore of the Derwent, it had grown to a prosperous colony, boasting a population of over 14,000 persons. Every year more emigrants were arriving, and more soil was cultivated. Progress in commerce was assisted by the foundation of the Van Diemen's Land Bank in 1824, by a group of local capitalists. Although the Bank issued notes, the subject of early banking could not be adequately dealt with within the limits of this paper. Although the currency was not in a state which we could term satisfactory to-day, when the period ended, the worst days were passed, and the forces were working which were to wipe out for ever the troubles of the earlier years.

C. ACKNOWLEDGMENTS.

The writer wishes to acknowledge his indebtedness to a number of gentlemen who have greatly assisted him in the search for materials, and in the writing of this paper.

He desires to thank Mr. J. Moore-Robinson, F.R.G.S., and Mr. Clive Lord, F.L.S., for placing records in their keeping at his disposal, Mr. A. Chitty, of Melbourne, for numismatic and general information, and Professor J. B. Brigden and Mr. L. H. Lindon, for valuable criticisms. He also wishes to acknowledge the kindly assistance of all members of the Historical Section of the Royal Society of Tasmania.

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Vol. 5 (1804-1806) (e)
Vol. 6 (1806-1808) (f)
Vol. 7 (1809-1813) (g)
Vol. 8 (1813-1816) (h)
Vol. 9 (1816-1818) (i)
Vol. 10 (1819-1822) (j)
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The Royal Society of Tasmania

ABSTRACT OF PROCEEDINGS

1925.

9th MARCH, 1925.

Annual Meeting.

The Annual Meeting was held on the 9th March at the Royal Society's Rooms, Tasmanian Museum, Hobart, the President of the Society, His Excellency Sir James O'Grady, K.C.M.G., presiding. Mr. L. Rodway, on behalf of the Society, extended a welcome to His Excellency as President of the Society. His Excellency in reply expressed his pleasure at being present, and hoped that during his stay in Tasmania he would be able to assist the Society.

The Annual Report was read and adopted. The following were elected members of the Council for 1925:—Mr. L. Rodway, Right Reverend R. S. Hay, Mr. W. H. Clemes, Dr. W. E. L. Crowther, Mr. W. H. Cummins, Major L. F. Giblin, Messrs. J. A. Johnson, A. N. Lewis, Dr. Sprott, and Mr. Lord (*ex officio*).

Papers.

The following papers were read:—

"Tasmanian Giant Marsupials." By H. H. Scott and Clive Lord.

"Some Notes on a Tasmanian Aboriginal Skull." By H. H. Scott and Dr. McClinton.

The following were elected members of the Society:—Miss H. Alexander, Messrs. W. Coogan, G. Cunningham, Mrs. Cunningham, Miss M. L. Reid, Messrs. R. Nettlefold and M. L. Urquhart.

Illustrated Lecture.

Mr. L. Rodway delivered an illustrated lecture on "Some Plants of the National Park (Mount Field)."

Conversazione.

At the conclusion of the meeting a Conversazione was held in the Art Gallery.

15th APRIL, 1925.

The Monthly Meeting was held in the Society's Rooms, on the 15th April, Mr. L. Rodway, Vice-president, presiding.

Papers.

The following papers were read:—

"The Basis of the Physical World as Indicated by Carrying as Far as Possible the Tenets of Relativity." By Professor A. McAulay.

"On the Occurrence of *Wolffia* in Tasmania." By L. Rodway.

Illustrated Lecture.

"The Aboriginal Camping Grounds of the North-West Coast of Tasmania." By Dr. R. Pulleine.

7th May, 1925.

The Monthly Meeting was held at the Society's Rooms on the 7th May, His Excellency Sir James O'Grady, K.C.M.G., presiding.

R. M. Johnston Memorial Lecture.

Professor F. Wood-Jones, D.Sc., F.R.S., delivered the R. M. Johnston Memorial Lecture for 1925, the subject of the lecture being "The Mammalian Toilet and Some Considerations Arising from It."

Presentation of the R. M. Johnston Memorial Medal.

Professor Wood-Jones was presented with the R. M. Johnston Memorial Medal for 1926.

9th June, 1925.

The Monthly Meeting was held at the Society's Rooms on the 9th June, Mr. L. Rodway, C.M.G., presiding.

The following were elected:—As Honorary Member, Professor F. Wood-Jones; as Corresponding Member, Dr. R. Pulleine; as Ordinary Members, Professor J. B. Brigden, Reverend B. Semmens, and Miss E. Giblin.

Illustrated Lecture.

"The Hands of Animals. A Chapter in Evolution." By E. E. Unwin, M.Sc.

13th July, 1925.

The Monthly Meeting was held in the Society's Rooms on the 13th July, Mr. L. Rodway presiding. The following were elected members:—Sir Alfred Ashbolt, Messrs. K. Shoobridge and D. C. Pearse.

Mr. Rodway drew attention to the present state of Lady Franklin's Museum, and moved:—"That in the opinion of this meeting, it is not being put to the use for which it was intended, and the Government be urged to resume it in the public interests." The resolution was carried.

Mr. P. B. Nye, on behalf of Dr. A. B. Walkom, read his paper, "Notes on Some Tasmanian Mesozoic Plants, Part 2."

Illustrated Lecture.

"A Review of the Birds of Tasmania." By M. S. R. Sharland.

Mr. W. F. D. Butler, Chairman of the Historical Section, drew attention to the fact that 3rd December, 1925, was the centenary of the Constitutional Independence of Tasmania, and made several suggestions for consideration by the Council, with a view to marking the event in a suitable manner.

10th August, 1925.

The Monthly Meeting was held in the Society's Rooms on the 10th August, Mr. L. Rodway, C.M.G., presiding.

Papers.

The following papers were read:—

"On a Phyllocarid from Tasmania." By F. Chapman.

"The Eared Seals of Tasmania." By H. H. Scott and Clive Lord.

Lecture.

"Native Tribes of New Guinea." By Minor Canon C. C. Robertson.

14th September, 1925.

The Monthly Meeting was held in the Society's Rooms on the 14th September, Mr. L. Rodway, C.M.G., presiding.

The following were elected members of the Society:—Messrs. A. L. Butler, G. L. Propsting, Norman Walker, and M. W. Winch.

Illustrated Lecture.

"Forestry, the Production of Soft Woods in Tasmania." By Lieutenant-Colonel Lane.

25th September, 1925.

A Special Meeting of the Society, in conjunction with the Tasmanian Field Naturalists' Club, was held on the 25th September at the Society's Rooms, Mr. L. Rodway, C.M.G., presiding.

Dr. William Colin MacKenzie, Director of the National Museum of Australian Zoology, delivered an Illustrated Lecture upon the "Scientific Importance of the Australian Fauna."

12th October, 1925.

The Monthly Meeting was held in the Society's Rooms on the 12th October, Mr. L. Rodway, C.M.G., presiding.

Sir Alfred Ashbolt presented the Society with a series of notes from Captain Booth's diary, prepared in London by Mr. Ronald Giblin, with the consent of Major Richmond, the owner of the original diary.

Papers.

"A Review of the Tasmanian Lepidoptera." By Dr. Jefferis Turner.

"New and Little-known Tasmanian Lepidoptera." By Dr. Jefferis Turner.

Lecturettes.

A series of Lecturettes dealing with the period during which Sir John Franklin was Governor of Tasmania were given by members of the Historical Section.

9th November, 1925.

The Monthly Meeting was held in the Society's Rooms on the 9th November, 1925, Mr. L. Rodway presiding.

Papers.

"Notes on the Journal of Captain C. O'Hara Booth." By R. W. Giblin, F.R.G.S.

"Tasmanian *Araneidæ*." By V. V. Hickman, B.Sc.

"Notes on Some Rare and Interesting Cryptogams." By L. Rodway, C.M.G.

Lecturette.

Sir Alfred Ashbolt delivered a lecturette concerning Captain Booth's Diary.

14th December, 1925.

The Monthly Meeting was held in the Society's Rooms on the 14th December, Mr. L. Rodway presiding.

Papers.

1. "Australian Fauna and Medical Science." By Professor William Colin MacKenzie, M.D., F.R.C.S., F.R.S. (Edin.).
2. "Notes on Early Tasmanian Currency." By J. Reynolds.
3. "The Eared Seals of Tasmania, *Arctocephalus tasmanicus, sp. nov.*" By H. H. Scott and Clive Lord.
4. "Tasman's Landing Place." By G. H. Halligan, F.G.S.

Illustrated Lecturette.

"The Location of Tasman's Landing Place in 1642." By G. H. Halligan, F.G.S.

ANNUAL REPORT

1925.

The Royal Society of Tasmania

Patron:

HIS MAJESTY THE KING.

President:

HIS EXCELLENCY SIR JAMES O'GRADY, K.C.M.G.

Vice-Presidents:

L. RODWAY, C.M.G.

A. H. CLARKE, M.R.C.S., L.R.C.P.

Council:

(Elected March, 1925)

L. RODWAY, C.M.G. (Chairman)
RT. REV. R. S. HAY, D.D.
W. H. CLEMES, B.A., B.Sc.
W. E. L. CROWTHER, D.S.O., M.B.
W. H. CUMMINS, A.I.A.C.
L. F. GIBLIN, D.S.O.
J. A. JOHNSON, M.A.
A. N. LEWIS, M.C., LL.M.
CLIVE LORD, F.L.S.
G. SPROTT, M.D., C.M.

Standing Committee:

W. H. CLEMES, L. F. GIBLIN, L. RODWAY, C. LORD.

Hon. Treasurer:

W. E. L. CROWTHER, D.S.O., M.B.

Editor:

CLIVE LORD, F.L.S.

Auditor:

R. A. BLACK.

Secretary and Librarian:

CLIVE LORD, F.L.S.

LIST OF MEMBERS

Honorary Members:

David, Sir T. W. Edgeworth, K.B.E., C.M.G., B.A., F.R.S., F.G.S. Professor of Geology and Physical Geography in the University of Sydney, the University, Sydney.

Mawson, Sir Douglas, B.E., D.Sc., O.B.E. Professor of Geology and Mineralogy, the University, Adelaide.

Spencer, Sir William Baldwin, K.C.M.G., M.A., D.Sc., Litt. D., F.R.S. Melbourne.

Wood-Jones, Professor F., M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S. The University, Adelaide.

Year of Election.

Corresponding Members:

1901 Benham, W.B., M.A., D.Sc., F.R.S., F.Z.S. Professor of Biology, University of Otago, Dunedin, N.Z.

1892 Bragg, W. H., M.A., F.R.S. Professor of Physics in the University College, London.

1901 Chapman, R. W., M.A., B.C.E. The University, Adelaide.

1875 Liversidge, Professor A. "Fieldhead," Coombe Warren, Kingston, Surrey, England.

1923 Pulleine, R., M.B. 163 North Terrace, Adelaide.

1902 Smith, R. G., D.Sc. Linnean Hall, Linnean Society of N.S.W., 16 College Street, Sydney.

1892 Thompson, G. M., F.L.S. Dunedin, N.Z.

1901 Wall, A., M.A. Canterbury College, Christchurch, N.Z.

Life Members:

1918 Avery, J. 52 Southerland Road, Annadale, Melbourne.

1908 Baker, H. D. American Consular Service, Washington.

1890 Foster, Lieut.-Colonel Henry. "Merton Vale," Campbell Town.

1905 Foster, J. D. "Fairfield," Epping.

1905 Grant, C. W. "High Peak," Huon Road.

1921 Harvey, D. H. "Manresa," Lower Sandy Bay.

1922 Jones, Sir Henry, Kt. Campbell Street, Hobart.

1894 Mitchell, J. G. Parliament Street, Sandy Bay.

1896 Sprott, G., M.D. Town Hall, Hobart.

Year of Election. **Members:**

1921 Anderson, G. M., M.D., C.M. Clare Street, New Town.

1923 Agnew, Miss K. Augusta Road, New Town.

1925 Alexander, Miss H. Brown's River.

1921 Allen, D. V., B.Sc. Launceston Technical School, Launceston.

1924 Allen, F. A. 13 Franklin Street, West Hobart.

1925 Ashbolt, Sir Alfred. "Lenna," Battery Point.

1921 Baker, H. S., LL.B., M.A. Griffiths, Crisp, and Baker, Collins Street, Hobart.

1887 Barclay, D. 143 Hampden Road, Hobart.

1921 Barr, J. S., M.D. (Glasgow). Lower Sandy Bay.

1890 Beattie, J. W. 28 Jordan Hill Road.

1918 Bellamy, H., J.P., M.Am. Soc. C.E., M.I. Mech. E., F.R. San.I. Government Hydraulic Engineer, Adelaide.

1924 Bennett, Dr. H. W., L.D.S., D.D.S. Brisbane Street, Launceston.

1903 Bennett, W. H. Ashby, Ross.

1921 Bertouch, V. von. Wellington Square Practising School, Launceston.

1921 Bethune, Rev. J. W. Church Grammar School, Launceston.

1922 Biss, F. L. U.S.S. Co., Hobart.

1912 Black, R. A. Department of Agriculture, Hobart.

1909 Blackman, A. E. Franklin.

1920 Blaikie, T. W. Practising School, Elizabeth Street, Hobart.

1918 Bowling, J. "Barrington," Tower Road, New Town.

1924 Booth, N. P. Messrs. Cadbury-Fry-Pascall Ltd., Claremont.

1925 Bowden, F. B. Jordan Hill Road.

1925 Bowerman, Captain. Marine Board, Hobart.

1923 Breaden, J. C. 12 Waverley Avenue, New Town.

1923 Brett, R. G. 53a Hill Street, Hobart.

1917 Brettingham-Moore, E., M.B., Ch.M. Macquarie Street, Hobart.

1925 Brigden, J. B., B.A. Tasmanian University, Hobart.

1911 Brooks, G. V. Director of Education, Hobart.

1922 Brownell, C. C. 117 Hampden Road, Battery Point.

Year of Election.

1907 Brownell, F. L. "Berwyn," Mercer Street, New Town.
1924 Budge, E. A., B.Sc. 302 Argyle Street, Hobart.
1918 Burbury, Frederick. "Holly Park," Parattah.
1919 Burbury, Charles. "Brookside," Moonah.
1925 Butler, A. L. Lower Sandy Bay.
1923 Butler, Mrs. G. H. Augusta Road, New Town.
1909 Butler, W. F. D., B.A., M.Sc., LL.B. Bishop Street, New Town.
1921 Butler, Reverend W. Corly. The Parsonage, Melville Street, Hobart.
1924 Calver, C. W. 112 Brisbane Street, Launceston.
1920 Cane, F. B. 90 High Street, Sandy Bay.
1913 Chepmell, C. H. D. Clerk of the Legislative Council, Hobart.
1920 Clark, W. I., M.B. Macquarie Street, Hobart.
1896 Clarke, A. H., M.R.C.S., L.R.C.P. "The Glen," Private Bag, St. Mary's.
1918 Clarke, T. W. H. "Quorn Hall," Campbell Town.
1910 Clemes, W. H., B.A., B.Sc. Clemes College, Hobart.
1922 Collier, J. D. A. The Librarian, Tasmanian Public Library, Hobart.
1925 Coogan, W. Lord Street, Sandy Bay, Hobart.
1924 Corstorphan, W. A. Toorak Avenue, New Town.
1924 Crabtree, R. W. The University, Hobart.
1920 Cranstoun, Mrs. F. A. 6 Gregory Street, Sandy Bay.
1924 Crisp, Cecil C. Lower Sandy Bay.
1911 Crowther, W. L., D.S.O., M.B. Macquarie Street, Hobart.
1917 Cullen, Rev. John. Macquarie Street, Hobart.
1918 Cummins, W. H., A.I.A.C. Manager, *The Mercury* Office, Hobart.
1925 Cunningham, Mrs. G. 22 Augusta Road, New Town.
1925 Cunningham, G. 22 Augusta Road, New Town.
1922 Davidson, R. Temple Chambers, Macquarie Street, Hobart.
1924 Davies, G. B. 111 Patrick Street, Hobart.
1919 Davies, H. W. "Abermere," Mount Stuart.
1923 Davis, Alfred. Lord Street, Sandy Bay.
1923 Davis, Charles. Red Chapel Road, Lower Sandy Bay.

Year of Election.

1908 Dechaineux, L. Technical College, Hobart.

1903 Delany, Most Rev. Patrick. Archbishop of Hobart, 99 Barrack Street.

1921 Dryden, M. S. 13 Hillside Crescent, Launceston.

1921 Eberhard, E. C. Charles Street, Launceton.

1923 Edwards, Hon. F. B., M.L.C. Ulverstone.

1919 Elliott, E. A., M.B. Main Road, New Town.

1918 Ellis, F. Education Department, Hobart.

1921 Emmett, E. T. Railway Department, Hobart.

1921 Erwin, H. D. Hutchins School, Hobart.

1918 Evans, L. Acting Director of Agriculture, Hobart.

1921 Eyre, H. Manual Training School, Launceston.

1902 Finlay, W. 11 Secheron Road, Hobart.

1918 Fletcher, C. E. Education Department, Hobart.

1921 Forward, J. R. Mechanics' Institute, Launceston.

1921 Fox, Miss. Ladies' College, Launceston.

1918 Gatenby, R. L. Campbell Town.

1923 Gibbings, R. A. C. 28 Antill Street, Hobart.

1922 Giblin, A. V. King Street, Sandy Bay.

1925 Giblin, Miss Ella. 326 Macquarie Street, Hobart.

1908 Giblin, Major L. F., D.S.O., B.A. Davey Street, Hobart.

1924 Giblin, W. W., M.R.C.S., L.R.C.P. Macquarie Street, Hobart.

1923 Gorringe, J. A. Kempton, Tasmania.

1923 Gould, H. T. Liverpool Street, Hobart.

1924 Gray, H. Fitzroy Place, Hobart.

1923 Green, Dr. A. W. 30 Parliament Street, Sandy Bay.

1921 Hall, E. L. 38 Lyttleton Street, Launceston.

1922 Halligan, G. H., F.G.S. "Hazeldene," Burns Road, Wahroonga, N.S.W.

1918 Harrap, Lieutenant-Colonel G. Launceston.

1924 Hawker, Mrs. J. F. 204 Davey Street, Hobart.

1919 Hay, Rt. Rev. R. S., D.D. Bishop of Tasmania, Bishopscourt, Hobart.

1924 Henry, Dr. C. C., M.B., F.R.C.S. St. John Street, Launceston.

1924 Heritage, F. W. Collins Street, Hobart

1921 Heritage, J. E. Frederick Street, Launceston.

Year of Election.

1921 Heyward, F. J., F.R.V.I.A. 43 Lyttleton Street, Launceston.

1915 Hickman, V. V., B.Sc. Mulgrave Crescent, Launceston.

1914 Hitchcock, W. E. Moina, Tasmania.

1921 Hogg, W. Public Buildings, Launceston.

1918 Hogg, G. H., M.D., C.M. 37 Brisbane Street, Launceston.

1922 Hood, F. W. Customs House, Hobart.

1921 Horne, G., V.D., M.D., M.S., Ch.B. Lister House, Collins Street, Melbourne.

1923 Hudspeth, W. H. "The Nook," Lower Sandy Bay.

1923 Hungerford, Mrs. "Red House," Fern Tree.

1923 Hungerford, Miss. "Red House," Fern Tree.

1923 Hurst, Miss R. 39 Bay Road, New Town.

1909 Hutchison, H. R. 1 Barrack Street, Hobart.

1922 Huxley. G. H., M.A. Kent Avenue, West Hobart.

1913 Ife, G. W. R., LL.B. Mortimer Avenue, New Town.

1925 Irby, L. G. Conservator of Forests, Forestry Department, Hobart.

1898 Ireland, E. W. J., M.B., C.M. Launceston General Hospital, Launceston.

1919 Jackson, George A. 79 Collins Street, Hobart.

1906 Johnson, J. A., M.A. Training College, Hobart.

1922 Johnson, W. R. Clemes College, Hobart.

1922 Johnston, J. R. Murray Street, Hobart.

1921 Judd, W., M.A. College Street, Launceston.

1911 Keene, E. H. D., M.A. Burnie.

1922 Kemp, Andrew. Stoke Street, New Town.

1922 Kennedy, J. 96 Montpelier Road, Hobart.

1924 Kennedy, Mrs. J. 96 Montpelier Road, Hobart.

1910 Kermode, R. C. Mona Vale, Ross, Tasmania.

1918 Knight, C. E. L., B.Sc. Claremont.

1919 Knight, H. W. National Mutual Buildings, Hobart.

1913 Knight, J. C. E. Claremont.

1924 Legge, R. W. Cullenswood, Tasmania.

1919 Lewis, A. N., M.C., LL.M. "Werndee," Augusta road, New Town.

1887 Lewis, Sir N. E., K.C.M.G., M.A., B.C.L., LL.B. Augusta Road, New Town.

Year of Election.

1912 Lindon, L. H. "The Lodge," Park Street, Hobart.

1900 Lines, D. H. E., M.B., Ch.B. Archer Street, New Town.

1921 Listner, W. P., M.A., LL.B. Augusta Road, New Town.

1912 Lord, Clive E., F.L.S. "Cliveden," Sandy Bay.

1921 Lord, Chester. "Mellifont," High Street, Sandy Bay.

1921 Lord, Raymond. "Handroyd," 6 Franklin Street, Hobart.

1924 Lord, Ronald. Derwentwater Avenue, Sandy Bay.

1922 Low, H. M. "The Gables," Pottery Road, New Town.

1893 McAulay, Professor A., M.A. The University, Hobart.

1923 McAulay, A. L., Ph.D. The University, Hobart.

1921 McClinton, Dr. R. 70 St. John Street, Launceston.

1922 Macleod, Mrs. L. H. High Street, Sandy Bay.

1919 Mackay, A. D. 83 Patterson Street, Launceston.

1918 Mansell, A. E. 331 Davey Street, Hobart.

1924 Marsh, James. "Westella," Elizabeth Street, Hobart.

1918 Martin, Brigadier-General W. Launceston.

1921 Masters, A. H. A.M.P. Chambers, Launceston.

1921 Meston, A. L. 115 Canning Street, Launceston.

1909 Millen, Senator J. Roxburgh, Newstead.

1907 Miller, L. S., M.B., Ch.B. 156 Macquarie Street, Hobart.

1921 Miller, R. M. State High School, Launceston.

1911 Montgomery, R. B. "Astor," Macquarie Street, Hobart.

1918 Murdoch, M.L.C., Honourable Thomas. 55 Montpelier Road, Hobart.

1921 Muschamp, Rev. E. Holy Trinity Rectory, Launceston.

1925 Nettlefold, R. Macquarie Street, Hobart.

1924 Newall, A. P. Charles Street, Moonah.

1882 Nicholas, G. C. "Cawood," Ouse.

1918 Nicholls, Sir Herbert, Chief Justice of Tasmania. Pillinger Street, Sandy Bay.

1910 Nicholls, H. M. Department of Agriculture, Hobart.

1921 Nye, P. B., M.Sc., B.M.E. Geological Survey Office, Hobart.

1917 Oldham, N. New Town.

1921 Oldham, W. C. 39 George Street, Launceston.

Year of Election.

1919 Oldmeadow, H. E. R. "Roseneath," Austin's Ferry.

1924 Oliver, H. Lindisfarne.

1922 Overell, Miss Lilian. Holebrook Place, Hobart.

1921 Padman, R. S. 56 St. John Street, Launceston.

1921 Patten, W. H. 59 Cameron Street, Launceston.

1923 Parker, Dr. G. M. Bellerive.

1922 Parker, H. T. "Montana," Bellerive.

1908 Parsons, C. J. 190 Davey Street, Hobart.

1925 Pearse, D. C. "Brown House," c/o P.O., Bellerive.

1923 Pedder, A. Stoke Street, New Town.

1922 Perrin, Miss K. C/o Mrs. F. Tyson, 227 George Street, Launceston.

1902 Piesse, E. L. "Merridale," Sackville Street, Kew, Melbourne.

1910 Pillinger, J. 4 Fitzroy Crescent, Hobart.

1918 Pitt, F. C. K. "Glen Dhu," The Ouse.

1925 Pratt, A. W. Courtney. "Athon," Mount Stuart Road, Hobart.

1925 Propsting, G. L. Earl Street, Sandy Bay.

1923 Purcell, G. A. Clemes College, Hobart.

1921 Reid, A. McIntosh. Geological Survey Office, Hobart.

1922 Reid, A. R. Curator, Beaumaris Zoo, Domain, Hobart.

1925 Reid, Miss M. L. The University, Hobart.

1921 Reid, W. D. Public Buildings, Launceston.

1921 Reynolds, John. Knocklofty Terrace, Hobart.

1925 Robinson, F. G. 42 Regent Street, Sandy Bay.

1884 Rodway, L., C.M.G. 77 Federal Street, Hobart.

1923 Rogers, G. H. B. 204 Davey Street, Hobart.

1921 Rolph, W. R. *Examiner* and *Courier* Office, Launceston.

1913 Ross, Hector. Cambridge, Tasmania.

1922 Sargison, H. Elizabeth-street, Hobart.

1921 Savigny, J. 21 York Street, Launceston.

1896 Scott, R. G., M.B., Ch.M. 172 Macquarie Street, Hobart.

1921 Scott, H. H. Curator, Victoria Museum, Launceston.

1925 Semmens, Rev. B. L. 17 Cedric Street, North Hobart.

1921 Sharland, M. S. R. *The Mercury* Office, Hobart.

Year of Election.

1921 Shields, M.L.C., Honourable Tasman. 13 Patterson Street, Launceston.

1925 Shoobridge, K. Glenora.

1921 Shoobridge, Honourable L. M. "Sunnyside," New Town.

1924 Shoobridge, Rupert. "Fenton Forest," Glenora.

1923 Shoobridge, S. E. C/o Messrs. H. Jones and Co., Hobart.

1923 Simson, Mrs. L. 3 St. George's Square, Launceston.

1917 Slaytor, C. H. Misterton, Doncaster, England.

1924 Smith, Colonel R. P. A.M.P. Society, Hobart.

1921 Smithies, F. 34 Patterson Street, Launceston.

1925 Stackhouse, C. K. R. 55 Patterson Street, Launceston.

1924 Stephens, Crofton. Messrs. Clerk, Walker, Stops, and Stephens, Collins Street, Hobart.

1919 Stevenson, Miss F. "Leith House," New Town.

1920 Swindells, A. W. 2 Patrick Street, Hobart.

1918 Taylor, W. E. Elboden Street, Hobart.

1920 Taylour, W. H. Equitable Buildings, Collins Street, Melbourne.

1922 Thomas, Lieutenant-Colonel L. R., D.S.O. The University, Hobart.

1921 Thomas, P. H. Agricultural Department, Hobart.

1923 Thomas, J. F. 64 Elizabeth Street, Sydney.

1922 Thompson, E. H. Lower Sandy Bay.

1918 Thorold, C. C. Hutchins School, Hobart.

1923 Unwin, E. E., M.Sc. Pendle Hill, Mortimer Avenue, New Town.

1925 Urquhart, M. L. Ashfield Street, Sandy Bay.

1918 Walch, P. B. C. King Street, Sandy Bay.

1925 Walker, Norman. The Hutchins School, Hobart.

1913 Wardman, John. Botanical Gardens, Hobart.

1918 Waterhouse, G. W. Messrs. Ritchie and Parker, Alfred Green and Co., Launceston.

1922 Waterworth, E. N. Poet's Road, West Hobart.

1922 Watson, D. W. "Undine," Glenorchy.

1922 Wayn, Miss A. L. C/o J. Moore-Robinson, Lower Sandy Bay.

1918 Weber, A. F. Lands Department.

1923 Webster, Hugh C. "Greystanes," Lower Sandy Bay.

1923 Wherrett, Miss A. Florence Street, Moonah.

1922 Winch, A. A. "Stornoway," Huon Road, Hobart.

1925 Winch, M. W. Stoke Street, New Town

1901 Wise, H. J. Lambert Avenue, Sandy Bay.

1924 Young, F. M., B.A. Montagu Street, New Town.

ANNUAL REPORT

1925.

The Council and Officers.

The Annual Meeting was held at the Society's Rooms, the Tasmanian Museum, Hobart, on 9th March, 1925.

The following were elected as members of the Council for 1925:—Messrs. W. H. Clemes, W. H. Cummins, Dr. W. L. Crowther, Major L. F. Giblin, Rt. Rev. R. S. Hay, Messrs. J. A. Johnson, A. N. Lewis, L. Rodway, and Dr. Sprott.

During the year eight meetings of the Council were held, and the attendance was as follows:—Mr. Rodway, 8; Mr. Lord, 8; Mr. Clemes, 6; Mr. Johnson, 6; Dr. Crowther, 5; Mr. Lewis, 5; Dr. Sprott, 5; Rt. Rev. R. S. Hay, 4; Major Giblin, 4; Mr. Cummins, 3.

The Council at its first meeting made the following appointments:—

Chairman of Council.—Mr. L. Rodway, C.M.G.

Secretary.—Mr. Clive Lord.

Standing Committee.—Messrs. Rodway, Clemes, Lord, and Major Giblin.

Editor of Papers and Proceedings.—Mr. Clive Lord.

Hon. Treasurer.—Dr. W. L. Crowther.

Trustees of the Tasmanian Museum and Botanical Gardens.—Doctors Crowther and Sprott, Messrs. Clemes, Johnson, Lewis, and Rodway.

Meetings.

During the year eleven ordinary and one special meeting of the Society were held, and were well attended. Details will be found in the Abstract of Proceedings.

Membership.

The membership of the Society shows a slight decrease. This may be traced to the financial depression which the State generally is experiencing at the present time. In any case, a membership of over 200 for such a comparatively small community may well be considered satisfactory, particularly so, as the membership roll has been carefully revised and contains only financial members. The roll at the end of the year showed:—4 Honorary Members, 8 Corresponding Members, 9 Life Members, and 225 Ordinary Members.

Historical Documents.

Last year's report referred to a most valuable collection of Franklin MSS. presented to the Society by Mr. W. F. Rawnsley, and it is the pleasant duty of the Council to place on record a continued interest in the work in which the Society is engaged of acquiring historical documents for its library. The most recent addition has been a series of notes on early Tasmanian history and notes on the Journal of Captain Charles O'Hara Booth prepared by Mr. R. W. Giblin, F.R.G.S.

Publication of Professor McAulay's Papers.

The Council records with great satisfaction that a second instalment of Professor McAulay's Researches on Relativity has been published by the Society in the face of great typographical difficulties, this work being done at the charge of a special fund subscribed by members and others for the purpose.

Library.

Reference was made in last year's report to the congested state of the Library, which makes orderly arrangement impossible, and seriously threatens the practical usefulness of the valuable collection. The position has naturally grown worse with the additions made during the year. Additional space is most urgently required. The Museum trustees are prepared to make available a storeroom in the basement under the present Library as soon as they can obtain funds for at least a temporary structure to house the stores, etc., now occupying the room. It is most earnestly to be hoped that the comparatively small amount required for this purpose will be provided this year.

Centenary of Constitutional Independence.

The Centenary of Constitutional Independence of Tasmania was celebrated by means of a dinner held at the Society's Rooms on the 3rd December, 1925.

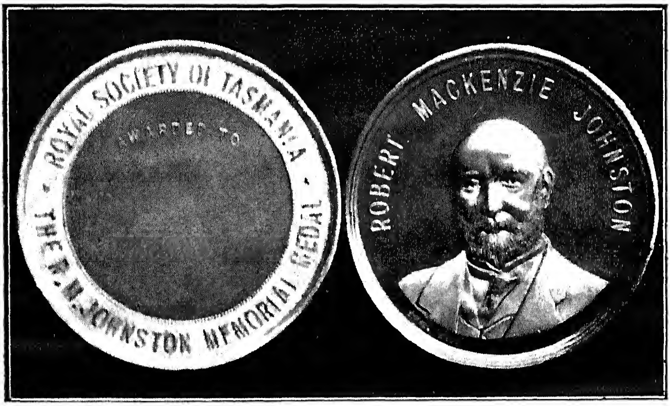
Speeches suitable to the occasion were made by several members of the Society and representatives of the Government and other public bodies present.

Further details concerning this function will be found in the Report of the Historical Section.

Obituary.

It is with regret that the Society has to record the death of the following members during the year:—The Honourable J. R. Chapman, Messrs. Robert Gould, Edward Hawson, W. L. May, and in addition the following Corresponding Members:—Professor W. A. Haswell and Mr. J. H. Maiden.

R. M. JOHNSTON MEMORIAL.



The R. M. JOHNSTON MEMORIAL MEDAL.

List of Awards:

1923 Sir T. W. Edgeworth David, K.B.E., C.M.G., B.A., F.R.S., F.G.S.
1925 Professor F. Wood-Jones, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc.

BRANCH REPORT

NORTHERN BRANCH.

ANNUAL REPORT FOR 1925.

Owing to the absence of our late Hon. Secretary from the State, no ordinary meetings of the Northern Branch were held until June. Mr. Halligan (Hon. Secretary), having then decided to remain in Sydney, forwarded his resignation, which was accepted with much regret, involving as it did not only the loss of his services as Secretary, but also as an active member of our Branch.

Mr. R. Stewart Padman was elected to fill the position. At the Annual Meeting, held in June, the following were elected members of the Council:—Hon. Tasman Shields, Messrs. H. H. Scott, J. E. Heritage, R. O. Miller, F. Smithies, J. R. Forward, F. J. Heyward, W. D. Reid, and R. S. Padman. At the conclusion of the formal business an illustrated lecture on "Town Planning" was given by Mr. F. J. Heyward, F.R.V.I.A.

On the 20th July Mr. H. H. Scott gave an interesting lantern lecture at the Museum, his subject being "Clouds."

On the 17th August we were favoured with a visit from Mr. J. C. Breaden, one of the members of our parent association. His lecture, "Wild Flowers and Ferns," illustrated by beautiful hand-painted slides, was much appreciated by the large attendance of members and visitors.

Our City Engineer, Mr. G. D. Balsille, on the 2nd December, gave a most interesting lecture on "Water Treatment and Purification." Although our meetings this year have been less in number than usual, the larger attendances at the last several meetings evidence a growing interest which we hope will be maintained next year.

SECTION REPORTS

HISTORICAL AND GEOGRAPHICAL SECTION.

During the past year the Section's activities have been confined to the preparation and presentation of an "historical" night before the October meeting of the Society, and assisting with the arrangements for the dinner with which the Society celebrated the centenary of the State's separation from New South Wales. The historical evening took the form of a series of lecturettes by members of the Section on the Franklin Period in Tasmania (1836-43). Whilst preparing their papers, the members found some new materials and hitherto obscured facts which will be of undoubted value when the history of the State can be again written. Mr. W. F. Dennis Butler (Chairman of the Section) gave an account of the interest Sir John and Lady Franklin took in education and the results of their labours in this field. Mr. A. W. Courtney Pratt read a descriptive paper on the life and character of Franklin, whilst an instructive paper on the administrative difficulties of the times was read by Mr. G. W. R. Ife. The explorations by land and sea of the Franklins were described by Mr. Clive Lord, F.L.S. Mr. Lord made special reference to the assistance given by the Franklins to scientific men as, R. C. Gunn, Joseph Milligan, and John Gould. He also pointed out that the Franklin MSS. in the possession of the Society contained some valuable facts and descriptions of Gould's work in Tasmania which were worthy of further investigation. This evening is the fourth given by the Section, and it is hoped that it will be possible to prepare an evening on the Denison Period (1847-55) next year.

It was largely through the efforts of the Section that any recognition of the completion of the century of Tasmania's separation from New South Wales was made in the State whatsoever. As a result, a dinner was held by the Society in its rooms on the evening of the 3rd December, 1925. Unfortunately, His Excellency the Governor (Sir James O'Grady, K.C.M.G.) was unable to attend owing to the death of the Queen Mother. His Excellency sent the following communication, which was read at the dinner:—

> Had circumstances permitted, I would have been with you at the dinner to commemorate the Centenary of Tasmania's Independence. I was, as you know, hope-

ful that the dinner would have taken place at Government House, but the death of our beloved Queen Mother made that impossible. Nevertheless, I feel I ought to write how glad I am, in the regrettable circumstances, that the Royal Society of Tasmania have resolved even in an abbreviated way to celebrate the occasion of our hundredth year of independence as a Sovereign State. I am sure His Gracious Majesty the King would agree that even midst our sorrow, no matter in how simple a manner, this epoch in our island history should be celebrated.

One hundred years ago the fructification of our liberties as a British community became a fact. From that time onward those liberties have grown broad based upon the people's will, until we reached the full manhood of a Sovereign State. In achieving this position surely the mind of our people when considering this centenary of creation will pause and give thought to the work of the pioneers who made this island State habitable for their sons and daughters, and have given to us richness of life, and, indeed, have made of the State, in modern, social, and intellectual considerations, no small partner in the evolution of the Empire to the place it now occupies in the world's community.

Since I have been in Tasmania I may, perhaps, have unduly stressed the relativity in importance of small as against large States, emphasising that in the mosaic of Empire a place is not to be judged by mere area.

Your celebration on December 3 will, I am sure, add more effectively to that idea—if it is worth anything—but will, anyway, pay to the pioneers their just tribute of praise and cement more securely, if need be, the fabric of Empire of which we are so reasonably proud. Trusting that you will have a successful gathering, and again regretting it is not possible to be with you. Yours sincerely, James O'Grady, Governor.

The Chairman of the Section in proposing the principal toast, "The Constitutional Independence of Tasmania," gave a résumé of the events which led up to separation from the Mother Colony. He dwelt on the attitude of the various Sydney Governors towards the young and growing colony, and showed how the first system of Government became an obstruction in the path of progress. Public opinion in the colony expressed itself, and a little later the Home Author-

ities saw fit to make the change. Response was made by a representative of the Government (Mr. R. Cosgrove, M.H.A.) and the leader of the Opposition, Hon. J. C. McPhee, M.H.A.

The Chairman of the Society (Mr. L. Rodway, C.M.G.) proposed a toast to "Historical Studies," which was responded to by Dr. W. L. Crowther, who emphasised the peculiar interest in the study of Tasmanian history and the necessity for its advancement.

The scope of the Historical Section is limited owing to the pressure of business on all its members. Nevertheless it seeks the co-operation of all members of the Royal Society in its search into the Past and placing the facts gleaned on record for the benefit of the community.

JOHN REYNOLDS,
Hon. Secretary.

EDUCATION SECTION.

The President was Mr. G. H. Huxley, and the Secretary Mr. H. T. Parker. Twelve members were enrolled during the year. Meetings were held monthly, the following subjects being dealt with:—

31st March.—Business Meeting.

21st April.—"Vocational Training in the Elementary Schools." By Mr. G. H. Huxley.

15th May.—"The Emotional Aspect of Education." By Mr. H. T. Parker.

16th June.—"Report on Rural Education in Denmark made by Director of Education in Victoria." By Mr. T. W. Blaikie.

28th July.—"The Tragedy of the English Public Schools." By Major L. F. Giblin.

18th August.—"The Cultural Aspect of Vocational Training." By Mr. L. Dechaineux.

15th September.—"Sex Instruction." By Mr. E. E. Unwin.

21st October.—"Some Aids to Character Training in Secondary Schools." By Mr. Walker.

H. T. PARKER,
Hon. Secretary.

THE ROYAL SOCIETY OF TASMANIA.

RECEIPTS AND EXPENDITURE, 1925. GENERAL FUND.

RECEIPTS.

	£	s.	d.
Balance brought forward	22	13	1
Government Grant	100	0	0
Subscriptions	206	17	0
Sale of Tickets, etc.	3	11	10
Contributions re Centenary Dinner (part)	25	2	0
Rent of Room	13	10	0
Donations to McAulay Fund	10	0	0
Refund from M.A.M. Fund	1	19	0
	£383	12	11

EXPENDITURE.

	£	s.	d.	£	s.	d.
Salaries				45	1	0
Paper and Proceedings—						
1924 (part)	94	1	8			
1925 (part)	111	8	2			
				205	9	10
Meetings, etc.				49	6	8
Library				16	18	11
Light and Fuel				3	16	6
Petty Cash and Postages				12	0	0
Northern Branch				10	10	0
Miscellaneous				6	3	0
Expenses re Centenary Celebrations (part)				28	16	0
Advance to M.A.M. Fund				2	14	0
Balance				2	17	0
				£383	12	11

W. L. CROWTHER,
Hon.. Treasurer.

CLIVE LORD,
Secretary.

I have compared the Receipt Book, Vouchers, and Bank Book with items particularised in the Cash Book and and found them to be correct.

R. A. BLACK,
Hon. Auditor.

29/1/26.

MORTON ALLPORT MEMORIAL FUND.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Revenue, 1925	9	15	0	Part Cost Mathews's "Birds of Australia"	10	10	6
Loan from General Fund	2	14	0	Refund of Loan to General Fund	1	19	0
	£12	9	0		£12	9	0

W. L. CROWTHER,
Hon. Treasurer.

CLIVE LORD,
Secretary.

I have compared the Receipt Book, Vouchers, and Bank Book with the items particularised in the Cash Book found them to be correct.

29/1/26.

R. A. BLACK,
Hon. Auditor

R. M. JOHNSTON MEMORIAL FUND.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Balance Brought Forward	16	2	10	Sollas's "Ancient Hunters"	1	10	0
Revenue, 1925	10	19	0	Balance	25	11	10
	£27	1	10		£27	1	10

W. L. CROWTHER,
Hon. Treasurer.

CLIVE LORD.
Secretary.

I have compared the Receipt Book, Vouchers, and Bank Book with items particularised in the Cash Book and found them to be correct.

29/1/26.

R. A. BLACK,
Hon. Auditor.

NORTHERN BRANCH.

ANNUAL FINANCIAL STATEMENT FOR THE YEAR ENDING 31st DECEMBER, 1925.

	£	s.	d.		£	s.	d.
Balance on 31st December, 1924	18	8	1	Advertising	2	7	0
Interest	0	15	4	Printing	2	10	6
Share of Subscriptions	10	10	0	Postages	0	14	6
				Travelling Expenses	2	7	6
				Balance in Bank	21	13	11
	£29	13	5		£29	13	5

R. STEWART PADMAN,
Hon. Secretary and Treasurer.

Compiled from the books and accounts of the Royal Society of Tasmania (Northern Branch), and certified to be in accordance therewith.

J. E. HERITAGE,
Hon. Auditor.

INDEX

Titles of Papers and New Genera and Species in **Heavy Type.**

Synonyms in *italics.*

APPENDIX

FRANKLIN PAPERS.

As mentioned in the Annual Report, 1924 (p. 155), Mr. W. F. Rawnsley presented to the Society a valuable collection of Franklin MSS. As circumstances permit, certain extracts will be published. The following account of an attempted visit to Port Davey is taken from Lady Franklin's Diary.

FRANKLIN PAPERS.—I.

Extracts From Lady Jane Franklin's Diary.

EXCURSION TO PORT DAVEY AND MACQUARIE HARBOUR, DECEMBER, 1838.

(Excursion Stopped At Recherche Bay.)

This excursion, or at least a visit to Port Davey, was first suggested to me by hearing Captain King say he wanted to go thither in search of Huon Pine. To this was added another motive, that of laying down S.W. Cape, whose precise position is disputed by different navigators. In combination with Mr. Gould I determined, if possible, not only to go to Port Davey, but to visit Macquarie Harbour on the Western coast, where a penal settlement was made, and after some years abandoned in the time of Col. Arthur. Since then it has been occasionally visited by vessels for wood, but its difficult access, there being a bar across the entrance of the harbour which in winter weather it is sometimes impossible to enter for days together, and its state of utter desertion make always a matter of some little risk and of diminished interest. As the only harbour, however, on the Western coast, I was very anxious to see it, and Mr. Kelly had been invited and engaged to accompany us as our pilot. This was some weeks ago, when we had thought of embarking, but were prevented by the weather.

On the present occasion, he was prevented by business from accompanying us, but recommended Mr. Bruce, of Research Bay, as a pilot quite as competent as himself to take us in. It was decided, however, that Mr. Lucas, a veteran pilot now residing on his farm near Mt. Louis,

should be the man, and a signal was made to him accordingly to hold himself in readiness. Mr. Frankland, Miss Barnett, and Mr. Lillie, and Mrs. Gould had all at one time wished or intended to be of the party. Various causes prevented them, so that at last we were reduced to 6. Myself and Elinor, Captain and Mrs. King, Mr. Gould, and Mr. Gunn. To these were added, besides the Pilot, servants, viz., the Snatchalls, and a baker from our home establishment, Mr. Gunn's assistant, and a servant of Mr. Gunn's. We were in the 3rd quarter of the moon and the weather, after some rain which had succeeded several sultry days, was beautiful. The *Tamar*, in which we were to enter Macquarie Harbour (the Schooner drawing too much water for the purpose), had been already dispatched to Port Davey, where we were to make the exchange, carrying the bulk of our provisions, which was calculated for an emergency of 6 weeks on board.

A light breeze brought us to the entrance of D'Entrecasteaux's Channel, about 9 o'clock on Tuesday morning, the 11th, when Captain Booth, who was making his way to Port Arthur with his bride in the *Vansittart*, came on board. Not being ready to see him I sent him a message by Elinor to beg him to get made for me at Port Arthur a light chair on poles such as we have been carried about in on Tasman's Peninsula, with the idea that it might be useful to me in our contemplated journey to the New Country. I also wrote by the *Vansittart* a few lines to Sir John.

About 2 o'clock, when within about 4 miles of Green Island, for which we were tacking, Mr. Gould went off in a boat with the hope of reaching it before us, and of finding some penguin's eggs which he is much in want off. He had landed on the island before and killed penguins, quails, ducks, etc. On this occasion he did not succeed in finding any penguin's eggs, but came back with a live penguin, and with the eggs of various gulls. Some of these were too hard to be blown, in which case he cut with the point of a penknife or of a small knife adapted for the purpose, an oval-shaped piece of the shell out of the side, emptied the egg, and replaced the shell.

A fine breeze rising about 5 o'clock carried us past Southport, but died away at sunset. When it rose again it was unfavourable from the S.W. A bank of dark clouds over the land obscured the sight of it, but afterwards rose and spread over the sky. We had a great deal of motion

through the night and at an early hour the following morning, Wednesday, much commotion took place in my cabin, owing to my heavy table breaking away from its lashings and the filtering machine on the drawers coming down and pouring its contents over all the books and other matters on the floor. Snatchall came to my assistance, but much out of sorts, declaring she would never come again. We anchored about 7 in the morning in Research Bay. I was not very well and suffered slightly from the toothache. The *Tamar* had come in the evening before, the weather being equally unfavourable for her proceeding to Port Davey. Mr. Gould went off in the morning to the Acteon Islands, which are about a mile distant from each other and at the distance of about 3½ or 4½ miles from Research Bay. The soil of them is sandy and much covered with scrub. He procured there 2 species of parrots he had not yet taken, an albatross, teal, gulls, and the eggs of the latter. Mr. Gunn and Captain King went up the northern division of the bay, called by the French, its first discoverers, Port du Nord, and ascended a little way the river which enters it and since called D'Entrecasteaux's River. After dinner Mrs. King, Elinor, and I were rowed to the same point under the direction of Captain King and Mr. Gunn. I was much struck with the bold and singularly shaped mountains which rise above the dense woods on the W. side of the bay. Between these and the water there appears to be a level tract of forest. On the N. side of the bay, a promontory forms a sort of inner bay which is familiarly known by the name of the Pigsty. On this point, a whaleboat, going down to Port Davey, had bivouacked the night before and was now away fishing, being detained by the same cause as ourselves. There is some shoal water in this pigsty but which may be avoided by keeping in the Channel. The mouth of D'Entrecasteaux's River is divided by a flat woody island, like that in Fleurieu River at Port Cygnet. The passage which presents itself on the r. seemed the only one fitted for the boat. We landed on its bank to collect the beautiful *Blandfordia nobilis**, whose branches of scarlet tubes, lined at their scalloped edges with yellow, show magnificently amongst the more delicate plants, generally white ones, which conceal the poorness of this white clayey soil. There is but this single species on V.D.L. but in N.S.W. is another, double the size, called *grandiflora*. Whilst thus engaged Captain King was in chase in his boat

* [=*Blandfordia marginata*.]

of a poor, solitary duck, which dived at the moment when, believing it to be the same as one he had wounded in the morning, he thought to have caught it. Mr. Gould, hearing the circumstances, thought she was more cunning than her pursuer, and was leading him away from her nest.

We were informed that a barque, supposed to be from England, was seen going up Storm Bay to-day towards Hobarton. The next day, Thursday 13th, 2 other vessels were reported as having been seen on their passage to Hobarton. It made me almost regret our own absence. Messrs. Gould and Gunn set off to-day to the head of the bay to a plain, which appears to run up many miles into the country the hill called South Cape, which presents towards the bay a steep and particularly denuded surface. Mr. Gunn ascended this hill which he thinks is about 800 feet high. It is of sandstone and has some veins of coal, but of a very indifferent kind. He saw a considerable extent of coast and the Mewstone rock from its summit. Mr. Gould expected a rich harvest from the appearance of the plain, both as respects quadrupeds and birds, but it was remarkably destitute. He brought back, however, the nest of an emu wren, and a parrot which he had not killed before. The plain was as poor in shrubs and plants as in living instances. The soil was wet, poor, and boggy. The plants were of stunted growth and there was no scrub. Mr. Gunn, however, found in some more favoured spots 2 plants which were new to him. Both were of the *Proteacea* family—the one, a beautiful shrub about 5 feet high growing very erect with clusters of white flowers, the other of the genus *Lomacia*, which comes next to the waratah in that family—all the *Proteacea*, Mr. G. told me, have no properties whatever and make even but bad fire-wood.

Recherche Bay has a peculiar interest as being the first harbour in which D'Entrecasteaux landed nearly 50 years ago. The French are said to have planted a garden here, and to have left inscriptions engraved on copper on some of the trees—Lucas, to whom we referred for local information, knew nothing of the garden, but 2 trees, he said, blown down by the wind, or uprooted by the beaking away of the bank, were lying on the beach on the S. which still bore the marks of the places where the plates had been inscribed, though they themselves had been removed. We landed on the S. shore, guided by Lucas, in search of these trees, and after passing a little way along a footpath in the fern which the whalers have traced from one station

to another, came down on the white sandy shore and walked on till the 2 dried and ash-col^{d}. old gum trees in question lay across our path side by side, presenting their decaying roots to the bank from which by violence they had been long divided. Lucas saw them in this state 6 or 7 and 20 years ago, when he first visited this spot. At that time one of the trees retained a portion of the copper-plate inscription which has since disappeared, probably like the rest carried off by the natives. The other tree contains an oblong hollowed space, about 3 fingers long and somewhat less broad, and of sufficient depth to have contained papers which it is supposed were inserted in it and closed down by the plate. The iron nails which fastened down the plate remained round the outer edge of the excavation—worn away and rusted. I carried off one of them, as well as one of two circular knobs carved in a lower part of the trunk near the root—some more pieces were afterwards subtracted from the decaying trunks by the gentlemen on a subsequent visit, the excavated box being left by us all uninjured.

Proceeding from hence along the shore towards the head of the bay, our olfactory nerves were sorely disturbed by the effluvia from some putrid whale carcases which were lying on the sand, and which were borne by the wind right against us. Thronging past these nuisances we reflected that for the comfort of future generations, the last of these whales would probably have deserted these shores before Mr. Frankland's bathing place of Ramsgate shall have built its lodging houses and bathing machines. This reserved township is at the head of the bay on the plain before mentioned, and on the banks of a small fresh water stream which comes down alongside of it. Our walk extended no farther than the right bank of the stream which we could not cross without wetting our feet, though it is much obstructed by sand and not navigable at least in its present state by boats. A fine lofty hedge of the Babialla, whose berries or seeds were roasted and eaten by the natives, borders the white shore in an even line for some distance eastward of the river, its rich and glowing colouring, though not in flower, forming a beautiful contrast to the taller line of the forest trees behind whose trunks it concealed. Returning to our boat, we crept along the other or northern side of the bay, where the sandy beach presents itself only in small patches slightly embayed between the loose dark rocks, which form the general outline and from which the forest immediately rises.

This side of the bay is more indented than the opposite one, and presents a double cove divided by a point which has a melancholy interest as being the spot on which the convict mutineers of the *Cyprus*, going to Macquarie Harbour landed Lieutenant Crowe, who had the military command of them, with his wife, who nearly perished in the woods, before assistance came to them.*

The first of these coves which we came to, or the most western, is much obstructed at its entrance along the W. side by sea-weed. A fine streamlet of water is seen on the beach, pointed out to us by Lucas. I asked him if the cove had any name, and being answered in the negative, observed to Captain King that I thought it deserved one, and that it could hardly have a better than Lucas; Captain King in consequence communicated to him my wish that it might henceforth be called *Lucas Cove*, upon which the old Pilot raised his cap from his head and looked infinitely pleased. He merited this compliment from me as having, when a boy, a few years younger, I believe, than Sir John, suffered shipwreck with him in the *Porpoise* on the Coral Reef. Poor Lucas is rather an interesting person when once one can succeed in overcoming the disgust which his first appearance excites. His face has been shattered and greatly disfigured by the contents of a pistol with which in a moment of passionate despair, being disappointed in love, he endeavoured to blow out his brains. His father was an officer in the 108th N.S.W. Regiment stationed in Norfolk Island where Lucas was born.

I was speaking of the coves on the N. side of the bay. The 2nd contains a whaling station of Messrs. Kerr and Alexander. The shears at the farther end of against which the carcase of the whale is erected to be cut up in pieces, indicates that there is deep water along the edges. We returned on board the schooner for dinner. As we were sitting round the table afterwards, a smell was wafted in which convinced Captain King and myself, who observed it at the same moment, that some change must have taken place in the wind, and immediately all hands were at work on deck to enable us to get under weigh. The *Tamar*, not waiting for our signal, was already making similar preparation. The breeze was from the Northward. Lucas seemed doubtful about it, the setting sun behind the hills,

*On reconsideration, I believe the landing place in question was the W. point of the most western of the coves which I have called Lucas Cove.

though not so red as when he had called our attention to it before as a sign of unfavourable weather, was not propitious, but he did not oppose our starting since we could easily return if the wind did not hold. As we passed Bruce's pilot station, he came off to us in a boat, remained a short time with us, and gave us more hope than Lucas of the weather improving. One of his boatmen was called on deck by Captain King to be examined as to a tale he had told the day before of a boat capsizing as it rounded S. Cape. He was on the look-out station, near this spot, when he saw the accident. He saw one man go over into the boat to leeward, and another *jump out to windward*, he climbed a tree to see better, but when he looked again, could find no trace of what had happened. He ran along the shore to his master, Bruce, when he arrived apparently much alarmed and said he had been pursued in his way by a black snake. Bruce and Lucas walked along the shore in search of an oar or some indication of the accident, but nothing was to be found, and this negative circumstance, together with the man jumping to windward, and even the black snake convinced Captain King it was all a story of his own invention. I was present when the man was questioned. He was minute in his details, and never contradicted himself, but the former property of liars amongst his class is, I am told, a fact of notorious generality.

I was struck as we moved along with the dense gloom and blackness of the woods as they rose immediately from the shore upon an outer base of dark-hued rocks. Over these the mountains behind Research Bay presented a noble and singular outline. I thought the French writers who expatiate so much on the terrible and severe aspect of nature in these Austral regions were not so much in the wrong. We came along the headland called S.E. Cape, or which rather, I believe, has no name at all though it is the most S. point of the island and had an extent of coast before us extending to the promontory called the Whalers' Head. We were not destined, however, to make any further progress. The sails began to shake, the wind had veered round again to the S.W., and about 9 o'clock it was determined to turn about and resume our former anchorage. A gun was fired to direct the *Tamar* also, and after a very rough passage we took up our anchorage again in Research Bay about midnight. The weather was so bad the next day, Friday 14th, that even the gentlemen could not go on shore, it not being deemed prudent to take out a boat. To me

it was a matter of indifference for I was suffering much from toothache, and kept my cabin and almost my bed the whole day. On Saturday I suffered still more in the head and under these circumstances could scarcely help rejoicing that there was nothing to do or to see from the enjoyment of which I should have been excluded. In the forenoon I heard rather a strange noise on deck but took no notice of it as the vessel was full of noises. Presently, however, Captain King desired to see me. I was in bed, but admitted him. It was to tell me we had broken our windlass, so that we could neither lie here in safety nor proceed with our voyage. At first he seemed to think of returning to Hobarton, but presently resolved to go to Port Arthur where we should arrive in four hours' time at the rate of 10 miles an hour before the gale. At last, however, and much more to my satisfaction, I found that the *Tamar's* 2 carpenters, in addition to a single one of our own, could repair the mischief for us on the spot in 2 days' time, there being good seasoned timber to hand which would answer the purpose. This being decided upon, Bruce volunteered to go up in his boat to Hobarton (where his wife is now staying) and to take letters to Sir John. I rejoiced in the opportunity, and a packet consisting of a letter from me, one from Elinor to Sophy, and one from Mr. Gould to his wife, was soon dispatched. It was calculated that Bruce would return before we should be ready to start and that if any vessel wanting to enter the channel in his absence should be seen, Lucas would take his place as Pilot. The gent^{n}. went on shore at night with a seine, lighted a fire and caught some fish. I was obliged to keep my room the whole of this day and the whole of the next also. The next was Sunday and Captain King read prayers and a sermon in the cabin to the cabin party.

We were at this time again in motion for Port Davey, a light favourable breeze having sprung up about 10 o'clock, which Captain King thought it well to take advantage of. Leaving the *Tamar* behind to bring on the letters which Bruce might be entrusted with. Our attempt this time was of shorter duration than before—a calm came on, then the wind returned to its old quarter and by 1 or 2 we had returned to our last anchorage which since the accident to the windless was in a more inland and sheltered position. I received a second visit from Captain King in bed, to inform myself of all these movements, and was again not sorry that we were at rest.

Monday 17*th*. It blew very hard, but not so much so as to prevent Messrs. Gould and Gunn going on shore. They visited the stream called Catamaran River in the Port du Nord. I felt better to-day and spent some time in the cabin, but was not able to eat there. Had the weather been fair to-day, Bruce might have returned by night but it blew so directly in his teeth that no hope of his arrival existed while the wind lasted with this violence. We had a new moon on Sunday last, and Lucas said the present bad weather might still last several days. We swung about at anchor during the night and woke to the tune of the same piping wind on.

Tuesday the 18*th*. The gentlemen visited the Catamaran River, round Rocky Point in the central of the 3 divisions into which Research Bay may be said to be divided. It is the most considerable stream which enters the bay, being much wider than D'Entrecasteaux River. At the entrance on the r. is a heap of rocks insulated at high tide with an old gum tree growing on the summit. It being now unfortunately low water and the boat not a very lightsome one, we made but little way and after grounding several times, turned about again. The river was about 120 yards wide at this spot. Mr. Gunn, who had been some way further, landed on the l. bank of the stream and found a rich soil, likely, however, from its lowness, to be overflowed. Mr. Frankland, in his map, has given the name of Catamaran River to a small creek considerably further to the North, or rather has marked it in a place where no river exists at all. There can be no doubt, however, that he meant the stream at the locality I am now speaking of. The greater part of the W. shore of this division of Research Bay was not surveyed by the French, probably on account of the shoal water under the banks on that side. As we looked at the beautiful range of mountains on this side we thought it was a pity they bore no name and determined to call them the Research Range, and as one of them stands out isolated from the rest and has a striking and noble appearance, we, on this account, and in compliment to Captain and Mrs. King, declared it should be King Mountain or Mount King.

Our next object was to land on Observatory Point on the E, side of the entrance to the Port du Sud (D'Entrecasteaux's anchorage) and where the astronomers of the expedition made their observations. By the emptied oyster shells, the cleared and trodden grass, the remains of cinders and

wattled wind screens it appears to be now resorted to as a place for bivouacking, as was lately the case with a boat going to Port Davey. Having remained a short time here we re-embarked, and coasted along a little further until we came to a beach which is covered with petrifactions of wood, many of which we collected. The rocks along this bay are covered with muscles. There are also oysters, but less numerous. A dish of muscles had been much admired to-day at the breakfast table, and a few oysters were discovered here, opened, and eaten on the spot. We now directed our course to the supposed locality of the garden planted by La Haye, botanical gardener to the French expedition. On looking at the map I find it cannot be far beyond the beach of petrifactions, but overshooting our mark we turned a point which imbays this part of the shore and proceeded to within a little distance of the mouth of a creek in a nook formed by another projection which is at the entrance of D'Entrecasteaux River. Crossing this creek we were led by Mr. Gunn through some thick cutting grass to a small ascent where, under the shade of 2 gum trees, a semicircular patch of sloping ground appears to have been entrenched from the cutting-grass bottom below, and Mr. Gunn thinks to have been once dug. The soil was of the most wretched description, white clay mixed with stones, and produced nothing but a little stunted and scanty fern and some few flowers amongst which was the beautiful Blandfordia which seems to bloom in worthless soils.* Nothing like a European plant or vegetable was to be seen. We were not at all satisfied with the French garden, but till we re-examined M. Bontemps-Beaupré's chart did not question its identity, finding no better place to select. On looking again at the chart, however, we saw we had gone too much to the North and that it was in another place we ought to have sought for it. Mr. Gunn accordingly wished to start the following morning at 6 in a second search for it. As we returned to our anchorage this evening we saw a schooner called the *Prince of Denmark*, which had been lying here since Sunday last, with her sails filled, coming out of the Bay in order to go up to Hobarton. (She is a vessel belonging to Messrs. Kelly and Hewitt, and hired on the present occasion by Mr. Stanley, of Launceston, to bring away some oil which had been deposited there and which is going to England in the *Augusta Jessie*.) We had informed ourselves of the probable

*Mr. Gunn found an orange variety of it, equally beautiful with the scarlet.

hour of her departure before we set off on our afternoon's excursion and felt assured we should have the whole evening to write letters in for Hobarton. Mr. Gould, who was on board the *Eliza* on our return, had witnessed her preparations for departure and made an ineffectual effort to detain her half an hour. As he could not prevail, he refrained from sending any letter himself to Mrs. Gould, out of kindness and delicacy to me who could not do the same to Sir John. Mr. Gunn's ready written letter to his brother was also left behind. The weather was much calmer this evening, but no Bruce arrived. Captain King called out to the master of the vessel as we passed under her stern to desire him to let the Lieutenant-Governor know he was not yet returned.

Thursday the 20th. We again entered the Catamaran River and pursued it for about a quarter of a mile up at high tide, when our further progress was arrested by fallen trees or snags. Landing here on the left bank of the stream, we carried away by the roots some native laurel, fern trees, and ferns, and gathered boughs of the beautiful native myrtle (really a beech, *Fagus cunninghamii*) which abounds here and of the celery-topped pine (*Podocarpus asplinifolium*)* (from its fruit being sessile, having a small foot-stalk). We have not obtained any wattle trees in the environs of Research Bay, the myrtle and the fern-tree indicate a rich and good soil. As we returned to the schooner after this short excursion we saw the *Vansittart* coming in to bring the monthly stores to Bruce's station, as well as to Bruny lighthouse. On waking in the morning I had found a packet of letters and newspapers from Sir John brought by Bruce, who reached town last Saturday. My packet was taken up to Sir John at 11 o'clock at night when he was asleep, but he was waked to read them, and Bruce set off on his return the next day at 12. The immediate return of the *Vansittart* enabled me to return very prompt answers to Sir John's letters. I was glad to find that he expressed no impatient nor unnecessary apprehensions about us. One of the ships which had been seen going up Storm Bay was the *Thebe*, from London, which brought no letters except the duplicate from the wine-merchant with the wine itself. The news sent me by Sir John is noted elsewhere. I wrote him a long letter of suggestions and recommendations in reply to his letter, endeavoured to make the best of our unfortunate detention, and to give every hope I could of the

*[Celery-top Pine, *Phyllocladus rhomboidales*.]

future. I did not tell him that Mr. Gould was worn out by our reverses, regretted the loss of time, and this very afternoon had been declaring with many apologies that he must go back in the *Vansittart.* His good humour under his prolonged disappointment had never failed, but his time was precious to him. When he came to V.D.L. he intended to stop only a month. How should he get through his work if he went on in this way? Mr. Gould was to my very great regret in this disposition when Mr. Gunn, Elinor, and I embarked again in the evening to visit the shores of that portion of the northern part of Research Bay where La Haye's garden was planted, and where Captain King had discovered signs of coal. A specimen of this, taken from the bank, together with our petrifactions, some of which were of a large size, and other roots were dispatched to town by the *Vansittart.* Mr. Gunn's researches for the garden (which he had made in the morning) were entirely without success, and he did not recommend us to go to the same locality on account of the difficulty of getting through the thick cutting-grass which was 6 feet high. I took the opportunity being alone with him of consulting him on some points in Sir John's letter, of asking his opinion of several individuals and he answered me with his accustomed candour. On our return to the schooner we found Mr. Gould no longer firm in his former determination to depart immediately, and on my telling him he must give me his hand in pledge that he would stay here and work longer if necessary, he, after a little hesitation, consented. As a little compensation I begged Captain King to let us remove either to Bruny, or to Muscle Bay, which would make very little difference when once the wind set in fair, and it was accordingly settled that at daylight we should sail for Muscle Bay.

We anchored here about 7 o'clock on Friday morning the 21st at the midsummer, or longest day of this country. The same S.W. wind and cold and cloudy weather continued. Mr. Smith came on board to breakfast, after which he and Mr. Gould went off to pursue the inlet at the other end of the bay to its extremity. The rest of us followed some time after in another boat, and passing Pelican Island, on which Nanny, the goat, had been previously landed for green-food, and exercise, we advanced towards the point which at the farther end of the bay narrows the entrance to the inner waters. Widening immediately after the passage of this narrow point, the inlet presents a fine basin, bounded with rather steep, but not lofty, banks with trees of moderate

size and density. It was in this basin, and not 200 yards from the shore on the right hand, that poor Burnett's boat capsized and himself met with a watery grave. It happened singularly enough; young Hurburgh, Burnett's companion, and then master of the *Vansittart*, was now steering our boat, having been removed into the command of the *Eliza*, in the room of his elder brother who is going to England on two years' leave of absence in command of the *Wallaby* (a colonial vessel, originally called the *Fanny*, built at Port Arthur, and purchased on speculation by Messrs Willit and Garrett, for sale in England.) Proceeding a little further and rounding a small point on the r. we passed in succession two coves, neither of which appeared to receive any fresh water. On the l. a projecting headland appeared to us to be an island and to have a passage on the other or l. side, as well as on this. But in this we were mistaken, the water, however, forms a bay or inlet under it. The banks were of only moderate height but rose at once from the water rather scantily wooded, so that the sky and the back mountains were seen through them. If similar in soil as we suspected it to be to the banks on the r., the land is of a very poor description. The beautiful Blandfordia, which we were near enough to admire on our right bank sufficiently indicated the poverty of the soil. A third and deeper cove or bay succeeds to the former ones and here the promontory ends, on the l. a broad and deep inlet is seen on that side, admitting a stream which appears to come down from the noble group of mountains at the back. Mount King and Snowridge were the highest of them and though seen in an altered position were easily recognisable. Snowridge, we thought, deserved its name from its preserving patches of snow on this, the longest summer's day. The inlet on the left is the most extensive body of water and receives, as we were afterwards informed by Mr. Smith and Mr. Gunn, a very pretty fresh water stream. We, however, continued our course in a direct line towards the head of the water before us, and which terminates in a rounded beach bordered by a hedge of flowering tea trees with a wall of lofty foliage behind it, leaving a dark gap, however, in the middle, where a small creek enters the bay. The hills rising behind this foreground complete a picture of great beauty. It was low water and the boat could not get up to the creek and scarcely was able to frighten away the swans and sea fowl which thickly studded the wet sands left by the retiring tide. We saw 4 pelicans standing in a procession line and looking like cari-

catures of something, I know not what, and innumerable gulls, duck, gannets, etc. We had passed several black swans which suffered us to approach so close that they were taken for *moulters*, which losing their feathers at midsummer cannot fly and are easily taken without firing a shot. This was not the case, however, for the boat nearing them a little more, they rose hissing in the air and moved off.

On our return to the schooner, we were landed on Pelican Island where we found Nanny and Mr. Smith's 4 sheep, the remains of the 12 which I think were here when we visited Muscle Bay before. The soil of the little island is sandy, but rather black looking. It contains probably 3 or 4 acres of land. Some old gum trees, almost denuded of foliage, rise to a considerable height on it. Mr. Smith placed two pair of rabbits on it, which have multiplied to 26. We started several of the young ones and it was a ridiculous thing to see Captain King amongst the rest hallowing and skipping after them. One poor young thing was caught by hand, but though Mr. Smith had begged the gentlemen to kill some if they pleased, it was released. A minor islet called Little Pelican is scarcely separated from the other at low tide.

We had to wait till a late hour for dinner, not wishing to sit down without Mr. Gould and Mr. Smith. I found the latter grown fatter since I saw him last, and equally amiable and contented. He seemed satisfied with his position and so does his wife, who occupies herself with botany, or at least with collecting and preserving flowers. He had almost 8 or 9 police cases brought before him this last whaling season. The punishment is chiefly fines, extending from a sum not less than £2 nor above £20. Their employers are subject to fines not less than £10 nor above £100. He mentioned that one case brought up to him was by a headman or manager who brought up 2 men to be punished because they were cowards, when the whale was seen, they refused to row up to it. Mr. Smith could not enter into a charge such as this. He believes the existence of a police station here has diminished, as it would be expected it might have done, the number of offences committed. They are sent up to Hobarton for punishment on the treadwheel when required. It was suggested that if there were a whalebone breaking establishment here the men under punishment might be more usefully employed.

APPENDIX.

Researches in Relativity

II.—The Basis of the Physical World as indicated by carrying as far as possible the Tenets of Relativity.

BY

ALEX. McAULAY, M.A.,

Professor of Mathematics, University of Tasmania.

(Read 15th April, 1925)

NOTE.—Paging and numbering of Articles continued from "Researches in Relativity, I.," P. and P., 1924, Appendix.

Additional Errata

In the first paper an unfortunate error of sign occurred early and has necessitated the corrections below. ${}^{c}\lambda$ and ${}^{c}\omega$ were correctly defined, the first in the last line of page 1 and the second in equation (2) on page 2, but the minus sign is incorrectly put before ${}^{c}\omega$ on line 24 of page 3; and the following corrigenda are the result:-

Page 3, line 24 For $-{}^{c}\omega$, read ${}^{c}\omega$

Page 4, equation (7) For $V_2\Delta^{c}\lambda$, read $-V_2\Delta^{c}\lambda$

Page 4, equation (10) For $-{}^{l}\kappa$, read $+{}^{l}\kappa$

Page 5, equation (14) Delete first minus sign.

Page 6, line 17 For

$${}^{c}\lambda V_0\Delta^{l}\lambda + V_1{}^{l}\lambda{}^{c}\omega = {}^{c}\lambda V_0\Delta^{l}\lambda + V_1{}^{l}\lambda V_2\Delta^{c}\lambda,$$

read

$$-{}^{c}\lambda V_0\Delta^{l}\lambda + V_1{}^{l}\lambda{}^{c}\omega = -{}^{c}\lambda V_0\Delta^{l}\lambda - V_1{}^{l}\lambda V_2\Delta^{c}\lambda$$

Page 6, equation (15) For $V_1{}^{l}\lambda{}^{c}\omega$ read $-V_1{}^{l}\lambda{}^{c}\omega$

I hope this completes the list of necessary corrections.

RESEARCHES IN RELATIVITY. II.

(Art.7 - 12)

THE BASIS OF THE PHYSICAL WORLD AS INDICATED BY CARRYING AS FAR AS POSSIBLE THE TENETS OF RELATIVITY

By Alex. McAulay, M.A.
Professor of Mathematics University of Tasmania

(Read 15th. April, 1925)

Art. 7. On the kind of invariantive relations to be expected in the physical manifold.

A summary of the present paper will be found in the opening paragraphs of Art. 12 below.

In the last paragraph but one of Art. 6 it was stated that researches already in existence were to occupy our attention. But the writer has found much of interest to add to the foundations. The present paper will be occupied with these additions.

To begin with, it may have seemed to the reader that Einstein's original basis and the writer's addition thereto given in the first paper — the basing of all Physics on the fundamental affine linity E_α — is somewhat artificial. I propose on the contrary to show that it is scarcely possible to conceive any simpler principle that can be reconciled with the beliefs of all relativists when one tries to put those beliefs down in a definite mathematical form. We all believe that the foundation is some reality (called action) situated at each element

$$db = dx_1dx_2dx_3dx_4$$

of a four-dimensional continuum, and the relative values of the portions of action in neighbouring elements. In a word we believe that there is no "action at a distance", but that everything is to be deduced in invariantive form from ${}^l\mathrm{W}$ and its derivatives of all orders, where ${}^l\mathrm{W}$ (henceforth to be used in place of ${}^l\mathrm{H}$ of the first paper) is the action density. The existence of such invariantive form is not obvious: much less is it obvious that we can obtain relations which are so far invariantive that they do

not even depend on the particular value given to ${}^{l}\mathrm{W}$ but are true simply and solely because ${}^{l}\mathrm{W}$ and its derivatives are of their respective classes. But this is precisely what the principle of our first paper ensures, though the reader may not be prepared for this statement, and our first task must be to establish it.

It is frequently more convenient to work with the logarithm of such a density as ${}^{l}\mathrm{W}$ rather than with ${}^{l}\mathrm{W}$ itself. Let x be any log-scalar-density, that is x is of the same nature as $\log{}^{l}\mathrm{W}$. We have first to consider how to arrive at invariantive relations among

x, Δx, $\mathrm{V}_0\alpha\Delta \cdot \Delta x$, $\mathrm{V}_0\alpha\Delta \cdot \mathrm{V}_0\beta\Delta \cdot \Delta x$, etc.,
where, as usual, α, β, etc., are any number of contravariant vector dummies.

Now, from the history of dealing with such continuums as we have under consideration, from Riemann to the present day, it may be taken for granted that the problem as so stated necessitates that our continuum must possess structure. (It is open to argument that without such structure we have provided no physical foundation at all.) Riemann provided this structure by the quadratic differential form. Civita-Levi, Weyl, Eddington and Einstein have developed what must be regarded as a generalisation more natural to our present point of view.

The basis of their structure was an intrinsic increment (due to parallel displacement) of vectors covariant or contravariant. But from our point of view an intrinsic increment of density (a scalar) is more fundamental. Let us put, in definite forms in parallel, the meanings of these two intrinsic increments. The use of the word intrinsic in these two senses implies the following two equations

$$x_\alpha = (\mathrm{D}_\alpha - \mathrm{S}_\alpha)x = \mathrm{V}_0\alpha(\Delta - \nu)x \qquad (1)$$

$$^{c}\tau_\alpha = (\mathrm{D}_\alpha - \mathrm{E}_\alpha)^{c}\tau \qquad (2)$$

where the expressions on the left, x_α , ${}^c\tau_\alpha$, are absolute increments of the scalar x described above, and of a covariant vector ${}^c\tau$. These absolute increments x_α, ${}^c\tau_\alpha$, are furnished by comparison with the intrinsic increments $\mathrm{S}_\alpha x$, $\mathrm{E}_\alpha{}^c\tau$ which are dependent on what may be termed the parallel displacement α (an infinitesimal contravariant vector) and quite independent of choice of coordinates. D_α merely stands for the ordinary differential operator $\mathrm{V}_0\alpha\Delta$ . . E_α is a linity of ${}^c\tau$, the linity itself being linear in α ; similarly S_α is a linity of the scalar x , the linity itself being linear in α ; that is to say S_α is of the form $\mathrm{V}_0\alpha\nu$, where ν is a vector. It follows that E_α , S_α , ν , are non-invariantive. Although non-invariantive the relations of these symbols to change of coordinates are quite simple, and it is rather surprising that, so far as I know, they have not hitherto been given in the case of E_α .

From the meaning just given to "intrinsic" it follows that x_α is a scalar density and ${}^c\tau_\alpha$ is a covariant vector. From this alone follow readily the relations just mentioned of E_α and ν , whether the change of coordinates be finite or infinitesimal. In the present paper infinitesimal change only will be treated of.

The reader will find no difficulty in proving that

$$\delta' x = -\mathrm{V}_0\Delta\sigma, \delta'\mathrm{V}_0\alpha\nu = -\mathrm{V}_0\alpha\Delta \,.\, \mathrm{V}_0\Delta\sigma \qquad (3)$$

$$\delta'\mathrm{V}_0\gamma\mathrm{E}_\alpha{}^c\beta = -\mathrm{V}_0\gamma\Delta \,.\, \mathrm{V}_0\alpha\Delta \,.\, \mathrm{V}_0{}^c\beta\sigma \qquad (4)$$

where δ' and σ are the δ and ϵ used in equations (2), (3), of Art. 15 of M.D.I. (2), in which place infinitesimal change of coordinates was first considered in our notation. (For σ . see Art.4 on p. 14 above.)

Note that nothing whatever has been added here to

the meaning (as originally introduced by Weyl and Eddington) of the affine linity E_α . I have in M.D.I. (5) already shown that absolute differentiation is a consequence of the meaning.

Note also some important pure mathematical truisms. Let x , ${}^0x$ be two scalars of type x ; ν , ${}^0\nu$ vectors of type ν ; and E_α , ${}^0E_\alpha$ two affine linities.

Then:-

(1) $x-{}^0x$ is an invariant. $\nu-{}^0\nu$ is a co-variant vector. $E_\alpha-{}^0E_\alpha$ is invariantive, i.e. it is a coexco vector linity whose form is linear in the contravariant vector α .

(2) Therefore the general values of x , ν , E_α , are given by

$$\left.\begin{aligned} x = {}^0x+y,\ \nu = {}^0\nu+{}^c\nu, \\ E_\alpha = {}^0E_\alpha+Y_\alpha \end{aligned}\right\} \qquad (5)$$

where y is an invariant, ${}^c\nu$ a covariant vector, Y_α a coexco vector linity which is linear in α . ${}^0x$, ${}^0\nu$, ${}^0E_\alpha$ are in equation (5) any convenient particular functions of their respective types.

(3) Both Δx and $E_\epsilon\epsilon$ are of type ν. In particular we may take ${}^0\nu$ to be either $\Delta{}^0x$ or ${}^0E_\epsilon\epsilon$.

Thus any fundamental scalar density furnishes standard forms for the particular functions ${}^0x$, ${}^0\nu$. The early study of Riemannian Geometry provides a form for ${}^0E_\alpha$. Let ϕ be any coexcontra self-conjugate vector linity. Then defining $\phi_{\alpha)}$ by

$$2\phi_{\alpha)}\beta = V_0\alpha\Delta\cdot\phi\beta$$
$$-V_0\beta\Delta\cdot\phi\alpha+\Delta V_0\beta\phi\alpha \qquad (6)$$

we may put ${}^0E_\alpha = \phi_{\alpha)}\phi^{-1}$ More particularly we may define ϕ by saying that $\phi=1$ in some selected system of coordinates, not merely at a single point but at all points.

Art.8. Insufficiency of Structure simpler than the affine.

A world with structure ν but without structure E_α

seems possible at first sight. $V_2\Delta\nu$ is covariant. This may be verified at once from equation (5) by putting $^0\nu = \Delta^0 x$ for $V_2\Delta^c\nu$ is known to be covariant. It may however be proved by a more familiar process, by summing the absolute increment of any x round a closed path and observing that as the sum equals the difference of two such values of x at a single point it must be invariant. Thus $V_2\Delta\nu$ is seen to be analogous to the general curvature derivable from the other kind of structure E_α.

Our present quest is for invariant relations as a basis, in our manifold, for a physical world. Can we find an invariant scalar density function ^lW, of the two invariantive quantities

$$^c\lambda = \Delta x - \nu, \quad ^c\omega = -V_2\Delta^c\lambda = V_2\Delta\nu \tag{7}$$

that must exist when structure involving an intrinsic x and an intrinsic ν exists? The necessary and sufficient condition that such a scalar function ^lW exists was found in our first paper (Art. 3, 4,) to be that

$$^lW^c\alpha = {}^c\lambda V_0{}^l\lambda^c\alpha + V_1{}^c\omega V_1{}^l\omega^c\alpha \tag{8}$$

where

$$^l\lambda = \%^c\lambda \,.\, ^lW, \quad ^l\omega = \%^c\omega \,.\, ^lW \tag{9}$$

As usual $^c\alpha$ is quite arbitrary. In a general n-fold equation (8) imposes n^2 scalar conditions on the $\frac{1}{2}n(n+1)$ scalar partial first derivatives of ^lW with respect to the same number of independent scalar variables. The number of conditions exceeds the number of scalars at our disposal to satisfy (8). Nevertheless in a four-fold the 16 conditions of (8) are satisfied in one case. For aught we know there may exist a class of such cases, and a four-fold world dependent on the satisfaction of (8) may be possible. The case referred to is when $^lW = \mathring{\iota} V_4{}^c\omega^2$ where $\mathring{\iota}$ as usual stands for $\iota_1\iota_2\iota_3\iota_4$, the product of all the primitive units.

However this be, such a world would not be that of natural physics. In it there would be no orthogonality or orthodromy or gravitation. There would only be bulk, inertia, and electric field.

Art. 9. Sufficiency of the affine structure.

ν denoting, as above, intrinsic structure, and z any log-scalar-density, the covariant vector $\Delta z - \nu$ is the absolute gradient of z. To be able to compare two such gradients at neighbouring points demands the affine structure. It is desirable henceforth to limit the meaning of the affine function E_α as previous writers have done by assuming $E_\alpha{}'\beta$ to be symmetrical in α and β, that is assuming E_α to be self-conjugate in α. The general E_α resolves into the two parts, self-conjugate and skew with respect to α, and the second part (which is invariantive) has no share in satisfying equation (4), the only condition demanded of the structure.

We may now take ν to be $E_\epsilon\epsilon$, and the structure thus involves an intrinsic x and E_α. The very simplest non-singular scalar density function ${}^l W$ (based on the structure) appears to be a function of ${}^c\lambda = \Delta x - E_\epsilon\epsilon$ and of the contracted curvature (a coexcontra vector linity) denoted in our first paper by $\psi - \frac{1}{2} V_1{}^c\omega(\;)$. ${}^l W$ is now a function of ${}^c\lambda, {}^c\omega = -V_2\Delta{}^c\lambda, \psi$, where ψ is self-conjugate. The necessary and sufficient condition for the existence of ${}^l W$ now becomes

$$ {}^l W{}^c\alpha = {}^c\lambda V_0{}^l\lambda{}^c\alpha + V_1{}^c\omega V_1{}^l\omega{}^c\alpha + 2\psi_\epsilon V_0{}^d\psi_\epsilon{}^c\alpha \qquad (10) $$

where

$$ {}^d\psi = \%\psi \cdot {}^l W \qquad (11) $$

Of the three ${}^c\lambda, {}^c\omega, \psi$ the first may be absent from ${}^l W$, but neither the second nor the third, if we are to have the full complement of n^2 scalar first partial derivatives of ${}^l W$ to satisfy (10). Physically this would seem to mean that all inertia is of electric origin and that there is but one conservation

law, the conservation of charge $V_0\Delta^l\kappa = 0$
It is thus of considerable interest that from our a priori mode of approaching the physical problem neither electric field, ${}^c\omega$, nor gravitation ψ, can be supposed absent. Also we may note that ignoration of a mass energy(given by ${}^c\lambda$) independent of charge seems arbitrary and artificial, for from our standpoint ${}^c\lambda$ seems more fundamental than either $V_2\Delta^c\lambda$ or ψ.

We shall return to (10) and its connection with the energy tensor later. Meanwhile we resume our a priori approach.

Art.10. Relativity tenets carried as far as possible.

It is open to argument that the principle "physical laws are independent of choice of coordinates" applies only to the original coordinates x_1, x_2, x_3, x_4 ; but it appears more natural to regard the scalars required to specify the structure as coordinates to which the principle also applies. Can this be done?

If the physical world is finite in each of its dimensions as held by De Sitter the answer is affirmative. To apply the principle in this its second aspect we have merely to vary these new coordinates, and ensure that the only physical reality namely $\int^n\int {}^l W db$ taken over the whole manifold remains unchanged. This is precisely what we did in the first paper (under the name of Stationary Action). If the manifold extends indefinitely in one or more of its dimensions we are not able fully to render $\int^n\int {}^l W db$ independent of choice of the new species of coordinates. The breakdown however can be pushed away to as remote a boundary as we please, and the argument for the naturalness of the process of the first paper retains much of its force.

Here ends our a priori enquiry. Some general aspects of the results of our method will now be considered.

Art. 11. The fundamental identity of relativity.

From the physical side (10) has to be viewed as the stress form (or energy tensor: no longer a "pseudo"

tensor) of the "laws of motion". When in (10) we replace ${}^{c}\alpha$ by Δ the laws take on their vector force form. Note that the electric field and gravitation as well as inertia are included in our meaning of the laws. Indeed a great unification of our ideas of the physical world arises from the straightforward interpretation of (10).

This interpretation was not possible earlier. It required a rearrangement of the foundation stones of general relativity, which was gradually effected by the labours of Weyl, Eddington, and Einstein (see the second sentence of the first paper). Now for the first time we have a complete parallelism of $({}^{c}\lambda, {}^{c}\omega, \psi)$ with the velocities, and of $({}^{l}\lambda, {}^{l}\omega, {}^{d}\psi)$ with the momenta, of nineteenth century holonomic dynamics. Hitherto this has not been possible in the case of ψ and ${}^{d}\psi$. A formidable obstacle to advance was left in the complexities resulting from the second differential coefficients and the non-linear form of the contracted curvature ψ.

Denote the identically zero form obtained by removing the left-hand member of (10) to the right-hand side by ${}^{l}U{}^{c}\alpha$; and, putting dc for an arbitrary infinitesimal invariant, let the differentials $d{}^{l}U$, $d{}^{c}\lambda$, etc., be replaced by corresponding fluxes ${}^{\bullet l}U$ ${}^{\bullet c}\lambda$, where $d{}^{l}U = {}^{\bullet l}U dc$, $d{}^{c}\lambda = {}^{\bullet c}\lambda dc$.
${}^{l}U$ does not naturally separate into three stresses, but the flux ${}^{\bullet l}U$ is the sum of three fluxes, kinetic ${}^{\bullet l}T$, electric ${}^{\bullet l}T'$, and gravitational ${}^{\bullet l}T''$
Thus

$$\left.\begin{aligned}
{}^{\bullet l}U &= {}^{\bullet l}T + {}^{\bullet l}T' + {}^{\bullet l}T'' = 0 \\
{}^{\bullet l}T{}^{c}\alpha &= {}^{c}\lambda V_0{}^{c}\alpha{}^{\bullet l}\lambda - V_1(V_2{}^{c}\alpha{}^{\bullet c}\lambda){}^{l}\lambda \\
{}^{\bullet l}T'{}^{c}\alpha &= V_1(V_1{}^{c}\alpha{}^{\bullet l}\omega){}^{c}\omega - V_1(V_3{}^{c}\alpha{}^{\bullet c}\omega){}^{l}\omega \\
{}^{\bullet l}T''{}^{c}\alpha &= 2\psi_\epsilon V_0{}^{c}\alpha{}^{\bullet d}\psi_\epsilon - 2V_1(V_2{}^{c}\alpha{}^{\bullet}\psi_\epsilon){}^{d}\psi_\epsilon
\end{aligned}\right\} \quad (12)$$

${}^{l}U_9\Delta_9$ is the sum of three corresponding forces ${}^{d}\nu$, ${}^{d}\nu'$, ${}^{d}\nu''$. Thus

$$\left.\begin{aligned} -{}^{d}\nu &= {}^{d}\nu' + {}^{d}\nu'' \\ {}^{d}\nu &= {}^{c}\lambda V_0 \Delta {}^{l}\lambda - V_1(V_2\Delta {}^{c}\lambda)\, {}^{l}\lambda \\ {}^{d}\nu' &= V_1(V_1\Delta {}^{l}\omega)\, {}^{c}\omega - V_1(V_3\Delta {}^{c}\omega)\, {}^{l}\omega \\ {}^{d}\nu'' &= 2\psi\epsilon V_0 \Delta {}^{d}\psi\epsilon - 2V_1(V_2\Delta\psi\epsilon)\, {}^{d}\psi\epsilon \end{aligned}\right\} \quad (13)$$

The reader should abserve that (12) and (13) follow from the mere assumption that ${}^{l}\lambda$, ${}^{l}\omega$, ${}^{d}\psi$ are the first partial derivatives of some scalar density function ${}^{l}W$ with respect to the independents ${}^{c}\lambda$, ${}^{c}\omega$, ψ. A second form of the assumption is that ${}^{c}\lambda$, ${}^{c}\omega$ ψ are the derivatives of ${}^{l}W^*$ with respect to the independents ${}^{l}\lambda$, ${}^{l}\omega$, ${}^{d}\psi$, where

$$ {}^{l}W^* + {}^{l}W = V_0 {}^{c}\lambda {}^{l}\lambda + V_0 {}^{c}\omega {}^{l}\omega + V_0 \psi\epsilon {}^{d}\psi\epsilon \quad (14)$$

On these results we now superpose those following out of the method we have based on Einstein's remarkable mathematical discovery. We find that ${}^{d}\nu''$ gives exactly the expression relativists demand for gravitational force; that ${}^{d}\nu'$ gives exactly the general electric field of M. D. I. (3), (the allied equation $V_3\Delta {}^{c}\omega = 0$ also following from our method); and that the conservation of energy must exist. To attain the accepted form for the matter term ${}^{d}\nu$ (as well as to interpret easily in any wanted sense the equation $V_0\Delta {}^{l}\lambda = 0$ as affirming the conservation of energy), we have to make the usual assumption that ${}^{l}\lambda$ contributes to ${}^{l}W^*$ the one term $\sqrt{(V_0 {}^{l}\lambda \theta {}^{l}\lambda)}$ where

$$\theta = {}^{d}\psi^{-1} \cdot |{}^{d}\psi^{1/(n-2)}| \quad (15)$$

The last paragraph asserts the truth of a series of statements which in their entirety may seem a little astonishing or even erroneous. It has been asserted that (13) agrees symbol by symbol with the usually

accepted equation of motion though based on different primary assumptions, and that the associated stress form or energy tensor is in no sense "pseudo". Why then, it will be asked, is the tensor of the usual theory "pseudo"?. The explanation is that our present method reveals two new identities which effect the simplification. From the single identity $^d\nu + {}^d\nu' + {}^d\nu'' = 0$, from which $^l\mathrm{W}$ has vanished and which involves only $^l\lambda$, $^l\omega$, $^d\psi$ and their Δ derivatives up to the second order, there arise three independent identities.

The facts about these three were correctly stated in the first paper, but it was not rendered clear why six instead of three do not arise. $^d\psi$ and $^l\omega$ may be given independent arbitrary values at every point, while $^l\lambda$ is taken to be zero. On now introducing $^l\lambda$ the forty-first equation $\mathrm{V}_0\Delta^l\lambda = 0$, (required to make the integral of $^l\mathrm{W}$ stationary) seems at first sight inconsistent with the previous forty equations, for $^l\lambda$ is expressible in terms of $^l\psi$, $^l\omega$ and E_α. Thus by a complex indirect way $^l\lambda$ is dependent on the previously assigned values of $^d\psi$, $^l\omega$, and the single identity is by no means an identity involving three independent symbols $^l\lambda$, $^d\psi$, $^l\omega$.

Let us now make a somewhat important departure from a usual procedure by supposing $^l\lambda$ to be involved in any way in $^l\mathrm{W}^*$ instead of in the very restricted and artificial looking form $\sqrt{(\mathrm{V}_0{}^l\lambda\theta^l\lambda)}$. On reflection the reader will I believe agree that the conservation equation $\mathrm{V}_0\Delta^l\lambda = 0$, and the "hydrodynamic term" $^d\nu$ in the equation of motion claim our first attention. We use Galilean co-ordinates; and find that, in the conservation equation, $\sqrt{(\mathrm{V}_0{}^l\lambda\theta^l\lambda)}$ $[= {}^lm]$ appears as three-dimensional density of mass-energy; and that, in the hydrodynamic equation, (on the assumption that so far as $^l\mathrm{W}^*$ depends on $^l\lambda$ it is

some function of ${}^{l}m$) the density of matter-inertia appears as ${}^{l}m(\partial/\partial^{l}m)^{l}W^{*}$ If these two three-dimensional densities are identified with each other in the strict mathematical sense, the usual assumption must be made that ${}^{l}W^{*}$ is linear in ${}^{l}m$. In the immediate neighbourhood of protons and electrons, that is where both densities are to be reckoned in many thousands of tons per c.c. the two must be identified to a very high order of numerical accuracy. Apparently at distances greater than 10^{-8} cm. the densities sink to values comparable with 10^{-7} gm. per c.c. We may well suppose that ${}^{l}W^{*}$ is of the form ${}^{l}mf({}^{d}\psi, {}^{l}\omega, {}^{l}m)$, where f is a finite invariant function of its constituents, for all values of ${}^{l}m$, inclusive of when ${}^{l}m$ is indefinitely increased.

It would seem then that we ought to call ${}^{l}\lambda$ the energy flux and reserve the name momentum vector for

$$-{}^{l}\lambda V_0{}^{l}\lambda{}^{c}\lambda/\sqrt{(V_0{}^{l}\lambda\theta{}^{l}\lambda)}.$$

<u>Art.12.</u> The problem of matter: protons, electrons, and the Bohr orbits.

Starting from Einstein's illuminating article in "Nature" we have now arrived at a beautifully rounded off relativity scheme of physics. In direct contrast however to Einstein's concluding words, we appear to have obtained a very promising insight into the true nature of the problem presented by matter, and in what direction to attack the position.

Submitting ourselves with severe interpretation to the ordinance "do naught but carry relativity tenets as far as possible", we have found many detailed results harmonizing with natural (as opposed to a priori) physics, and not a little which was lacking from former presentations of relativity. Examples are the conservation of energy, the existence of a true energy tensor, and the formulation as an identity of the laws of motion, understood here to include electric field and gravitation. We shall now show that great atomic concentrations of matter and of electric

charge each necessarily presuppose the other. Later, general reasons will be given for expecting such concentrations, and something very like the Bohr orbits accompanying them.

The more I reflect on the dual (matter-electric) aspect of the pair of allied vectors ${}^{1}\lambda$, ${}^{c}\lambda$, the more I realise that a long-felt want has here been supplied, a basic natural and simple unification of the three great physical entities matter, electricity, and energy.

Though we may affirm that the dual aspect is prima facie evidence that a rotating mass should be a magnet, the remarks at the end of Art.11. render it improbable that any numerical deduction is possible from present-day knowledge.

We are on safer, and very interesting, ground when we observe that very high electrostatic potential (irrespective of sign) and very high material density necessarily go together. This, of course, admirably accords with our knowledge of protons and electrons.

Consider the case of a hydrogen atom, where we have very high positive and negative potentials at the proton and electron and an intervening locus at which the potential sinks to zero. This suggests that in our theory we may have to recognise the existence of negative mass. On this point one is inclined at first to argue somewhat as follows. (1) There is no a priori diffculty in supposing mass, either as energy or inertia, to be negative. (2) The total apparent mass of a proton, or of an electron, includes a term due to its charge because of the conservation of energy (though in the absence of such conservation the argument for this electric inertia seems to fail). (3) Observation shows that this total mass is, in each case, positive (for otherwise the two particles would separate), but in the case of the electron the result may be due to the positive electric term masking a negative term contributed by ${}^{1}\lambda$.

There seems, however, a very real reason preventing us from recognising negative mass. We seem instead to be impelled to assume that when we reach a point at which ${}^{l}m = 0$ we ipso facto reach a boundary of the physical world. In the arguments (1), (2), (3) above, we tacitly assumed that the single scalar condition expressed by saying that the electrostatic potential is zero gives rise to the four scalar conditions expressed by saying that ${}^{l}\lambda = 0$. For we assumed that, on each side of the locus ${}^{l}m = 0$, the scalar ${}^{l}m$ is real. Now, wherever ${}^{l}m = 0$ and ${}^{l}\lambda$ is finite our interpretation of the conditions is that the velocity of light has been attained. The simple view is that this condition holds at the internal boundary of every electron and that in every proton ${}^{l}m$ attains a very large, or perhaps indefinitely large, value.

The work of earlier writers suggests a first form for ${}^{l}\mathrm{W}^*$ namely ${}^{l}m - \frac{1}{2}l\mathrm{V}_0{}^{l}\omega{}^{d}\psi^{-1}{}^{l}\omega$ where the "extensive" meaning understood for ${}^{d}\psi$ is that which makes ${}^{d}\psi^{-1}\mathrm{V}_2\alpha\beta = \mathrm{V}_2{}^{d}\psi^{-1}\alpha{}^{d}\psi^{-1}\beta$. The considerations advanced in the last paragraph suggest a first modification of this form by the addition thereto of $-l$. The general nature of the Bohr theories suggests a further change by which the invariant coefficient of l is replaced by a corresponding exponential thus

$$\left.\begin{aligned} {}^{l}\mathrm{W}^* &= {}^{l}m - l\cosh\sqrt{(\mathrm{V}_0{}^{l}\omega{}^{d}\psi^{-1}{}^{l}\omega)} \\ &= {}^{l}m - l\cos\sqrt{(-\mathrm{V}_0{}^{l}\omega{}^{d}\psi^{-1}{}^{l}\omega)} \end{aligned}\right\} \quad (16)$$

Let us enquire whether (16) should lead us to expect the automatic formation of those intense concentrations and the Bohr orbits whose existence has hitherto proved so baffling. Such an enquiry may perhaps suggest further modifications of (16) before we seriously face the labour of exact mathematical analysis. The argument will be easier to follow if we write (16) in the following invariant form

$$\left.\begin{aligned} \mathrm{W}^* &= m - \cosh\sqrt{(\mathrm{D}^2-\mathrm{H}^2)} \\ &= m - \cos\sqrt{(\mathrm{H}^2-\mathrm{D}^2)} \end{aligned}\right\} \quad (17)$$

W^* stands for $l^{-1l}\mathrm{W}^*$ and m for $l^{-1l}m$. D (displacement) and H (magnetic force) are the invariant magnitudes of the two vector densities ${}^{l}\delta$, ${}^{d}\zeta$, given by

$$\left.\begin{aligned} {}^{l}\delta &= \mathrm{V}_1{}^{d}\psi^{-1l}\lambda^{l}\omega, \\ {}^{d}\zeta &= -\acute{\upsilon}\mathrm{V}_3{}^{l}\lambda^{l}\omega \end{aligned}\right\} \quad (18)$$

(17) suggests that perhaps the proper form for the exponential is $\cosh \mathrm{D} + \cos \mathrm{H} - 1$ in place of $\cosh \sqrt{(\mathrm{D}^2-\mathrm{H}^2)}$. Our quarternion notation suggests several alternative forms.

Think now of (17) in connection with the problem of the atomic concentrations, and first consider the great (mainly stagnant) interstellar spaces. We may suppose the normal condition here to be that D, H and $\theta - 1$ are all very small or zero according as radiation is present or absent. Further we may plausibly endow these great physically empty spaces with the negative property of contributing zero to the action integral. Thus the characteristic of empty space is that $m = 1$. (Perhaps a more plausible criterion for the value of m in empty space should be sought in equipartition of energy between the whole of ether and the whole of gross matter; but I believe the search will always fail from the want of a natural boundary between the two.)

When just now we said $\theta - 1$ is nearly zero in the ether we tacitly assumed that in a practical but no absolute sense it is possible to choose a system of coordinates which is natural and simple. From this point of our argument let us use such a system and permit ourselves freely to contemplate an evolution of the physical world as time progresses.

At some remote epoch in the past all the energy of the universe existed as a chaos or welter of radiation.

Gravitation at once began to make such fortuitous congestions of energy as existed still more congested and to make the emptier places still more empty. Each congestion had a high electric potential and the descending potentials in the emptier surroundings had but one limit namely zero, corresponding to a zero value of energy density. Incipient atoms had evolved from primeval chaos. Each atom consisted of a pair of singular points, at one of which was a concentration of energy and at the other a sink of potential and a boundary of the physical world. Equipartition of energy necessarily ensued, and the incipient atoms had become the hydrogen atoms with which we are familiar to-day. Needless to say the details of this brief sketch of the growth of physical law are not to be insisted upon. Rather are they given to indicate in what direction exact analysis is called for.

Similarly (17) while possessing several instructive features bearing on the possible mode of origin of atoms is not very likely to prove the exact form required. If (18) is to be of use in this problem we should expect a general explanation to run somewhat as follows. (1) For a proton D^2-H^2 is positive, and D and m assume large values. (2) For an electron D^2-H^2 is negative and m is between unity and zero. (3) The apparent mass of an electron is practicly entirely of electric origin. (4) The energy levels of Bohr's Theory no doubt depend on the periodic cosine term in W^*, but the working out of the mathematical details will probably prove difficult.

Near an isolated proton when the electron has been removed it is not improbable that, between limits of distance from the centre of the proton about 10^{-5} cm. to 10^{-10} cm., m varies approximately inversely as the distance, rising from value unity. When the electron is present it probably pushes a sort of pit or crater of unit density into these denser previously spherical layers, the crater forming a kind of cometary tail,

the electron itself being the head or nucleus. On the other hand it is possible that the critical Rydberg length, about 10^{-5} cm., is closely connected with the linear dimension of an isolated electron rather than an isolated proton, and in that case we should expect to attain the value 2 near an isolated proton, at some distance between 10^{-10} and 10^{-13} cm.

Why, it may be asked, do not the pairs of concentrations we have pictured run to the extreme of forming one great single pair instead of a vast number of atoms? Four alternative general answers seem reasonable. First, analysis may show that the pairs when once formed will be highly stable. Secondly, the large number of atoms may depend on a constant of intergration, perhaps in association with the invariant y of our first paper. Thirdly, a very large mathematical number (such as $e^{16\pi^2}$) may be involved in the ratio of the linear dimensions of the universe to those of an atom. Fourthly, the bounding vacuities inside electrons may be original unchangeable features of the universe, and form necessary nuclei for the atoms to gather round.

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